

## ABSTRACT

Title of Document:

INTO THE WATER: CLEANSING THE  
NATION'S SYMBOLIC RIVER

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2013

Directed By:

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This thesis proposes a center and attendant water cleansing systems that will simultaneously cleanse the waterways of the Potomac River in Washington D.C. through filtration and the removal of aqueous impurities as well as hosting research and exhibitions demonstrating ways humans can successfully improve the earth's natural watershed systems. This particular example in our nation's capital will also provide recreation and education space for the community to learn about the health of water systems and feature global strategies to improve our watersheds in the symbiotic landscape of the national mall and surrounding monumental landscape.

INTO THE WATER: CLEANSING THE NATION'S SYMBOLIC RIVER

By

Nicole Adriene Hinkle

Thesis submitted to the Faculty of the Graduate School of the  
University of Maryland, College Park, in partial fulfillment  
of the requirements for the degree of  
Master of Architecture  
2013

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## Acknowledgements

I would like to thank my mother for her unconditional support and understanding as I moved through this trying process.

I would also like to thank my committee, Professors Draper, Quiros and Rockcastle for their commitment, enthusiasm and great support during this process.

# Table of Contents

Table of Contents .....	iv
List of Figures .....	v
Chapter 1: Introduction .....	1
<u>Water as Inspiration</u> .....	1
Chapter 2: The Potomac River .....	3
<u>Introduction</u> .....	3
<u>Description of the Potomac River Basin</u> .....	5
<u>History of Site</u> .....	14
<u>Future of Site</u> .....	16
<u>Roaches Run Waterfowl Sanctuary</u> .....	19
<u>Water Quality</u> .....	22
Chapter 3: Natural Cleansing Systems .....	24
<u>Introduction</u> .....	24
<u>Filtration</u> .....	28
<u>Nutrient Reuptake</u> .....	32
<u>Other Site Strategies to Aid in Water Cleansing</u> .....	39
Chapter 4: Precedents .....	42
<u>On the Water: Palisade Bay</u> .....	42
<u>New Urban Ground</u> .....	43
<u>+Pool</u> .....	44
<u>Lady Landfill Skyscraper</u> .....	46
<u>High Line</u> .....	50
<u>Peter Jay Sharp Boathouse / Sherman Creek Center</u> .....	52
<u>App-grading Wet Slums</u> .....	57
Chapter 5: Architectural Response .....	59
<u>Potomac Sanctuary Park</u> .....	59
<u>Research and Education Center</u> .....	66
<u>Closing Thoughts</u> .....	78
Bibliography .....	79

## List of Figures

[Figure 1] Potomac River Basin

[Figure 2] Depth Map of Potomac River Around Washington, D.C.

[Figure 3] Daily Tidal Fluctuations Washington, D.C.

[Figure 4] Hydrologic Systems in Washington D.C. Metropolitan Area

[Figure 5] Combined Sewer Outfall diagram

[Figure 6] Combined Sewer Outfall Locations in Washington D.C. Metropolitan Area

[Figure 7] Maps of the Potomac River from 1802-present day

[Figure 8] Maps of the Projected Sea Level Rise of the Potomac River

[Figure 9] Diagram of Water Exchange

[Figure 10] Site Diagram of Roaches Run Waterfowl Sanctuary

[Figure 11] Diagram of Hydrologic Cycle

[Figure 12] Diagram of Components of Hydrologic Cycle

[Figure 13] Diagram of Percolation and Transpiration

[Figure 14] Diagram of Smart Street

[Figure 15] Anatomy of an Oyster

[Figure 16] Section Diagram of + Pool Wall Section

[Figure 17] Quaking Bog photograph

[Figure 18] Area Required for Contaminant Removal Diagram

[Figure 19] Nutrient Reuptake Diagram

[Figure 20] Structure of Floating Treatment Wetland

[Figure 21] Floating Treatment Wetland Section

[Figure 22] Diagram of Floating Treatment Wetland Structure

[Figure 23] View of Floating Treatment Wetland from Underwater

[Figure 24] Absorbent W photograph

[Figure 25] Native Fish and Vegetation Species

[Figure 26] Precedent: On the Water: Palisade bay

[Figure 27] Precedent: New Urban Ground

[Figure 28] Precedent: + Pool

[Figure 29] Precedent: + Pool Section

[Figure 30] Precedent: + Pool Detail

[Figure 31] Precedent: Lady Landfill Skyscraper Underwater Perspective

[Figure 32] Precedent: Lady Landfill Skyscraper Above Water Perspective

[Figure 33] Precedent: Lady Landfill Skyscraper Sections

[Figure 34] Precedent: High Line photograph

[Figure 35] Precedent: section diagram of materials

[Figure 36] Precedent: High Line Section Drawing

[Figure 37] Precedent: Peter Jay Sharp Boathouse photograph

[Figure 38] Precedent: Peter Jay Sharp Boathouse dock photograph

[Figure 39] Precedent: Peter Jay Sharp Boathouse dock detail photograph

[Figure 40] Precedent: Sherman Creek Center wetland photograph

[Figure 41] Precedent: Sherman Creek Center education garden photograph

[Figure 42] Precedent: App-Grading Wet Slums

[Figure 43] Precedent: App-Grading Wet Slums

[Figure 44] Process Work

[Figure 45] Title Image



[Figure 46] Hydrologic Systems in Washington D.C. Metropolitan Area

[Figure 47] Potomac River Depth

[Figure 48] Potomac Sanctuary Park Site Plan

[Figure 49] Strategies

[Figure 50] Diagram of Site – Phase 1

[Figure 51] Diagram of Site – Phase 2

[Figure 52] Implications of Cleansing Systems

[Figure 53] Transformative Processes

[Figure 54] Potomac Sanctuary Park Research and Education Center Site Plan

[Figure 55] Approaching the South Entrance

[Figure 56] Diagram of Secondary Axis

[Figure 57] Diagram of Primary Axis

[Figure 58] Plan

[Figure 59] Longitudinal Section

[Figure 60] Transverse Section

[Figure 61] Spatial Diagram

[Figure 62] Section Perspective Highlighting Cleansing Columns

[Figure 63] Material Diagram

[Figure 64] Structural Detail

[Figure 65] Perspective Looking East From the Water

[Figure 66] Perspective Overlooking the Sunset on the Lake

## Chapter 1: Introduction

### Water as Inspiration

*“The sand sloped down into a clear blue infinity. The sun struck so brightly I had to squint...I kicked the fins languidly and travelled down, gaining speed...and the momentum carried me on a fabulous glide. The diminished volume of my body decreased the lifting force of water, and I sank dreamily down.”*

*Jacques-Yves Cousteau<sup>1</sup>*

I have always been fascinated by the natural worlds that exists so near us, but are difficult to perceive. Under the surface of the water, sound is dulled and a silent, alien space exists. Jacques-Yves Cousteau documented his experiments with the aqualung; his descriptions of what he experienced in the depths are magical, frightening and exciting. There is so much richness in the water on our planet and so much mystery. Yet, we treat our water bodies like they can absorb all of our waste and stay healthy. Natural restoration and cleansing efforts are necessary now to heal and prevent greater damage caused by human neglect, abuse and ignorance.

Through architecture, this project intends to create an experiential connection that takes people from land to water and knits together improvement strategies to provide new educational and research opportunities and foster innovation. Educational programs will enhance discovery and wonder. Recreational opportunities will encourage engagement and appreciation for cleaner the water. Quiet spaces invite

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<sup>1</sup> Cousteau, Jacques-Yves with Frédéric Dumas and James Dugan. *The Silent World*. New York: Ballantine Books, 1953.

visitors to be silent; to take in the strange, magical qualities and otherworldliness of a place that is so near yet so distant.

This thesis will propose a center that will simultaneously cleanse the waterways of southern Washington D.C., through filtration, oxygenation and the removal of aqueous impurities and toxins, as well as examine ways humans can better contribute to the health of natural water systems. It can also improve recreation, education and research space for the community to learn about the health of water systems and suggest global strategies to coexist with water in a symbiotic manner.

## Chapter 2: The Potomac River

### Introduction

*“...the Potomac is emblematic of what’s at stake for rivers nationwide...”*

–American Rivers<sup>2</sup>

The Potomac River is the reason for being of the nation’s capital. Over time, the river was neglected and used as a dumping ground. In the late 1800s and early 1900s a decrease in vegetation and aquatic life is observed in the river. In 1932, the metropolitan DC population of 575,000 people begins to dump untreated wastewater into the Potomac. The bacterial contamination of this activity forces swimming to be forbidden and endangers local fisheries. By 1956, the amount of raw sewage released into the Potomac River is double that of 1932 and is described as “an open sewer.” By 1969 the Potomac River Basin Advisory Committee describes the river as “a severe threat to the health of anyone coming into contact with it.”<sup>3</sup>

In the later part of the twentieth century the Clean Water Act, the Federal Clean Water Action Plan and the Water Quality Improvement Act are put into action. These measures are moving in the right direction but more drastic action is needed. It is time to reexamine our relationship with the Potomac River and bring it back to its former glory. Rehabilitating that Potomac River will be a symbol to the rest of the

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<sup>2</sup> American Rivers. “American Rivers Names America’s Most Endangered Rivers of 2012.” Last modified May 15, 2012. <http://www.americanrivers.org/newsroom/press-releases/american-rivers-names-americas-most-endangered-rivers-of-2012/>.

<sup>3</sup> Interstate Commission on the Potomac River Basin. *Timeline of the History of Water Quality in the Potomac Basin*. <http://www.potomacriver.org/39-facts-faqs/facts-faqs/96-timeline>.

nation, and the world, that we are committed to restoring the water bodies in the United States and provide ideas of how to do so because:

Water is essential for all dimensions of life. Over the past few decades, use of water has increased, and in many places water availability is falling to crisis levels. More than eighty countries, with forty percent of the world's populations, are already facing water shortages, while by year 2020 the world's populations will double. The costs of water infrastructure have risen dramatically. The quality of water in rivers and underground has deteriorated, due to pollution by waste and contaminants from cities, industry and agriculture. Ecosystems are being destroyed, sometimes permanently. Over one billion people lack safe water, and three billion lack sanitation; eighty percent of infectious diseases are waterborne, killing millions of children each year.

-World Bank Institute<sup>4</sup>

It is not acceptable to live in these conditions. The action of constructing a center where the ideas of natural water cleansing can come together, be tested and understood by the public is the catalyst the Potomac River needs.

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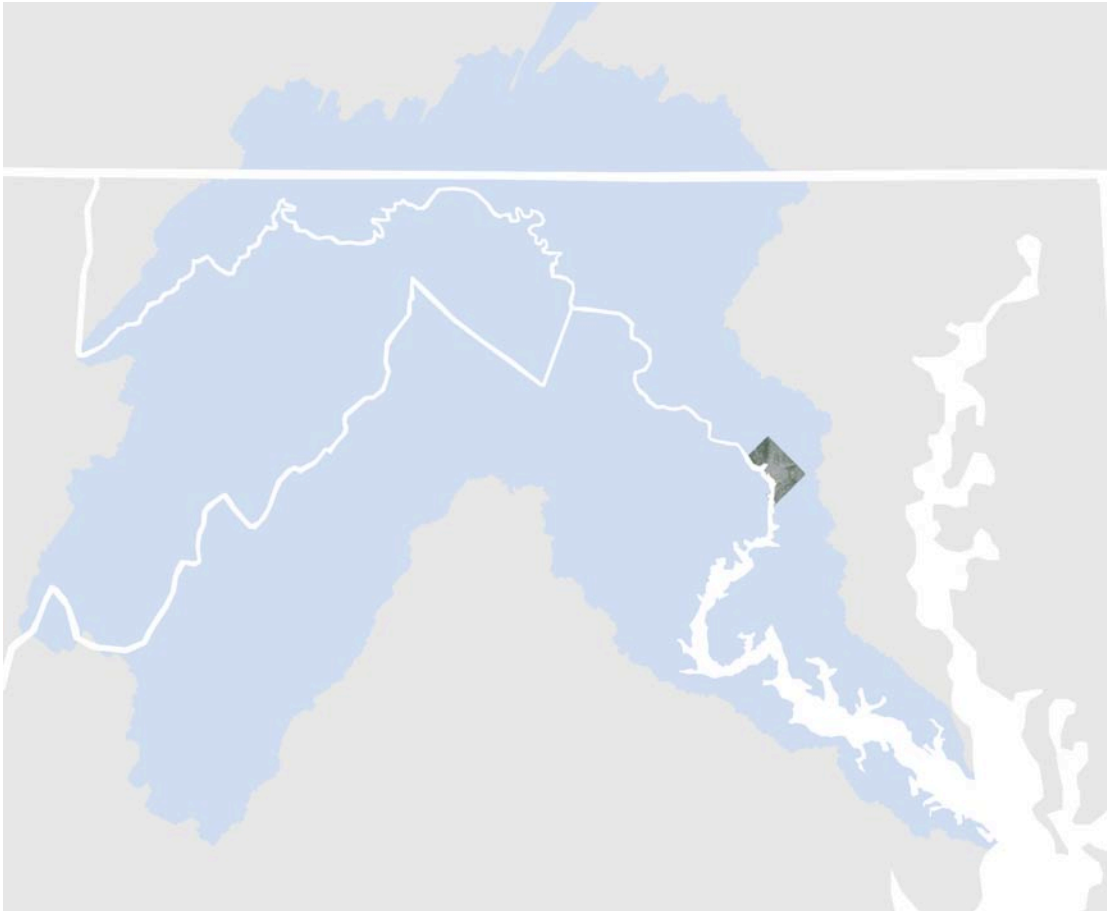
<sup>4</sup> "Water Policy Reform Program," World Bank Institute, accessed November 10, 2013, <http://wbi.worldbank.org/wbi/>.

Description of the Potomac River Basin

*And Potomac flowed calmly, scarce heaving her breast,  
With her low-lying billows all bright in the west,  
For a charm as from God lulled the waters to rest  
Of the fair rolling river.*

Paul Hamilton Hayne-*Beyond the  
Potomac*<sup>5</sup>

The Potomac River Basin encompasses 14,670 square miles in the District of Columbia, Maryland, Pennsylvania, Virginia and West Virginia. (See Figure 1).



[Figure 1] Potomac River Basin<sup>6</sup>

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<sup>5</sup> Paul Hamilton Hayne. *Poems of Paul Hamilton Hayne*. Chapel Hill, NC: University of North Carolina at Chapel Hill, 1999.

The climate is temperate and has an average temperature of 53 degrees Fahrenheit. The average annual precipitation is 40 inches. The river begins as a small spring in West Virginia and flows into the Chesapeake Bay at Point Lookout, MD. The river is tidal beginning upstream from Washington D.C. The river becomes brackish downstream from Washington D.C. and salinity gradually increases as it nears the Chesapeake Bay and eventually Atlantic Ocean.<sup>7</sup>

Near Washington D.C. the Potomac River is freshwater and tidal. The Potomac River, adjacent to Washington D.C. is approximately 2,000 feet wide and relatively shallow. In the figure 2 below, the Mean Lower Low Water is indicated, which is the average height of the lowest tide recorded at a tide station each day during the recording period.<sup>8</sup>

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<sup>6</sup> Information from NOAA.gov. Image by author.

<sup>7</sup> “National Water-Quality Assessment—Potomac River Basin,” USGS, accessed November 9, 2013, <http://md.water.usgs.gov/publications/ofr-91-157/ofr-91-157.html>.

<sup>8</sup> “Office of Coast Survey,” NOAA, accessed September 29, 2013. <http://www.charts.noaa.gov/OnLineViewer/12289.shtml>.



[Figure 2] Depth map of Potomac River Around Washington, D.C.<sup>9</sup>

<sup>9</sup> Information from “Office of Coast Survey,” NOAA, accessed September 29, 2013. <http://www.charts.noaa.gov/OnLineViewer/12289.shtml>.  
Image by author.

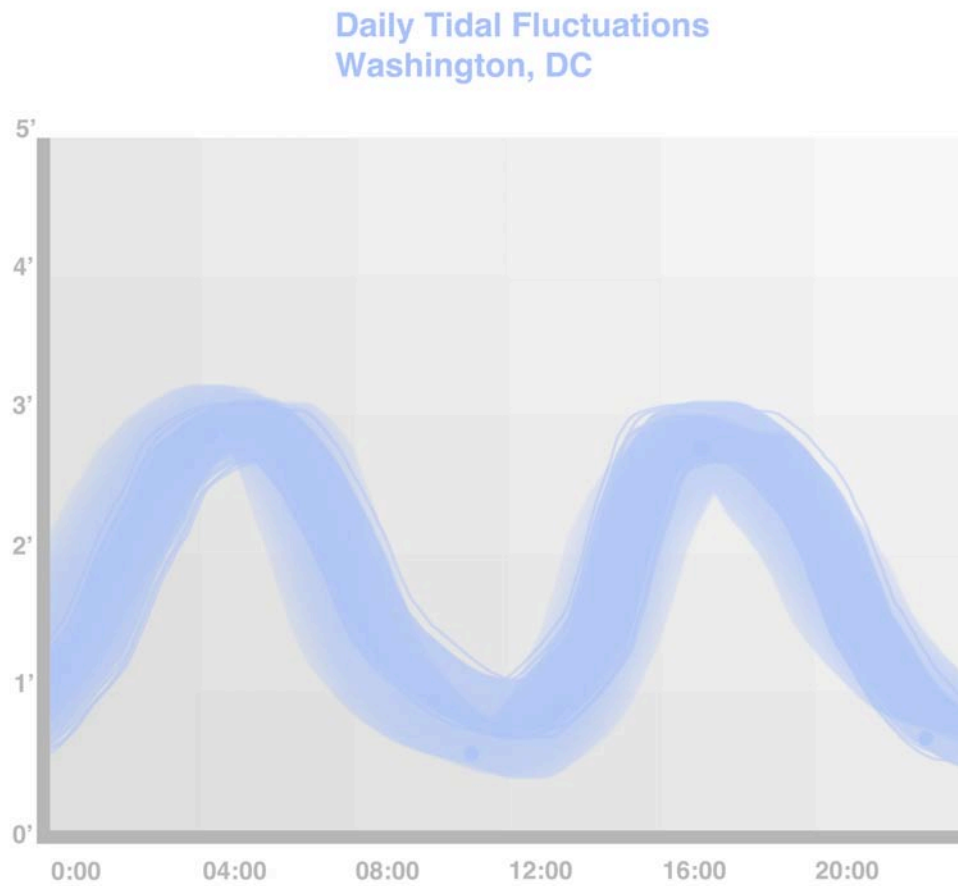


The deepest parts of the river are indicated in the darkest color and are approximately 24 feet at low tide. So, at high tide, the deepest part of the river would be approximately 28 feet. The average flow of the Potomac River near Washington D.C. is 7,440 million gallons per day. This accounts for about 15 percent of the inflow to the Chesapeake Bay.<sup>10</sup> The river flows at an average of 3.4 miles per hour.<sup>11</sup> The daily tidal fluctuations average three feet. According to the National Oceanic and Atmospheric Administration (NOAA), the tide changes approximately every six hours, seen in figure 3.

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<sup>10</sup> “National Water-Quality Assessment—Potomac River Basin,” USGS, accessed November 9, 2013, <http://md.water.usgs.gov/publications/ofr-91-157/ofr-91-157.html>.

<sup>11</sup> data from USGS 01653000 Cameron Run Station at Alexandria, VA

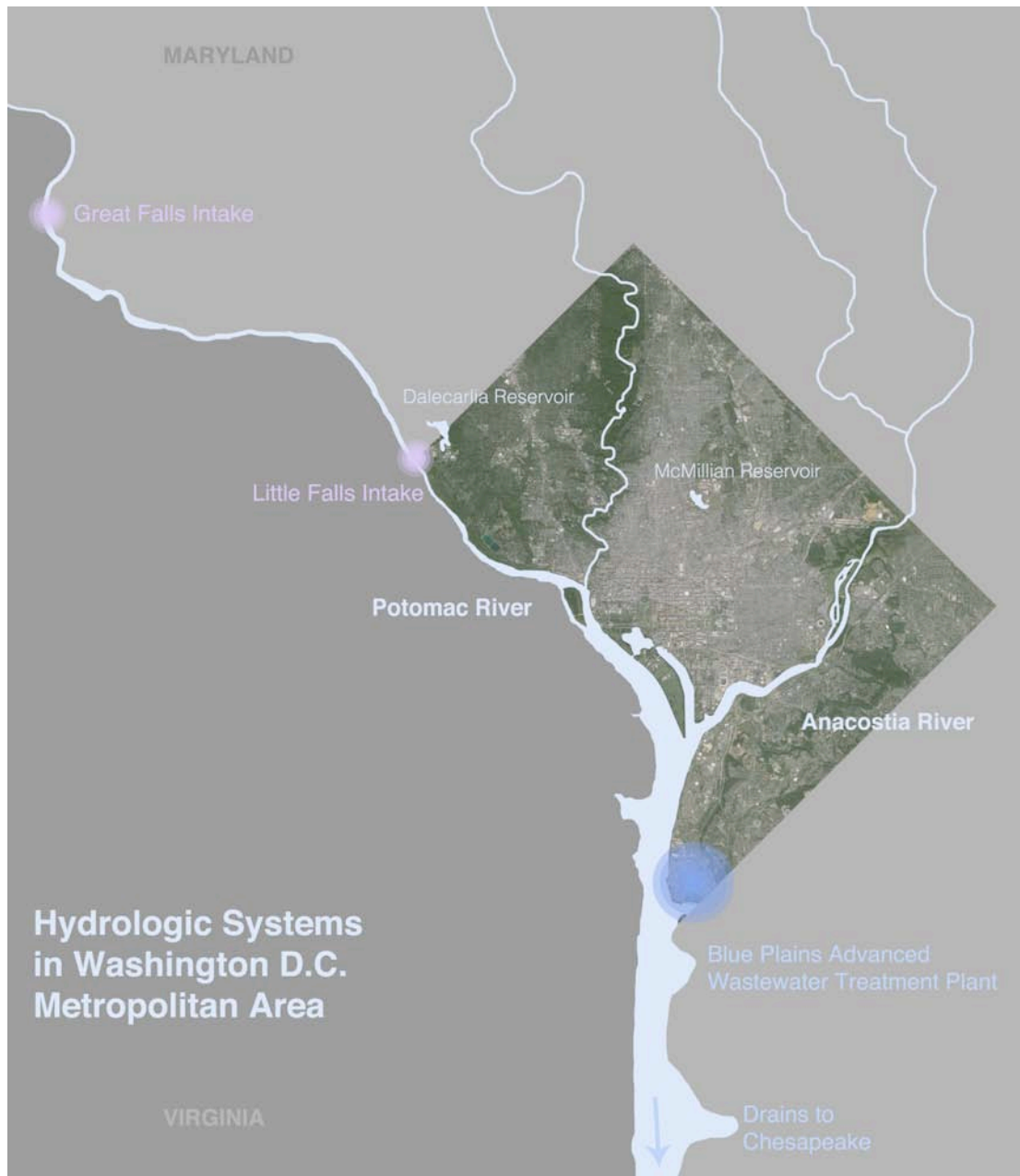


[Figure 3] Daily Tidal Fluctuations Washington, D.C.<sup>12</sup>

Figure 4 below illustrates the hydrological cycle around Washington D.C.

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<sup>12</sup> Information from: “Tides and Currents, Washington D.C., station 8594900,” NOAA, accessed September 29, 2013. <http://www.tidesandcurrents.noaa.gov/map/>. Image by author.



[Figure 4] Hydrologic Systems in Washington D.C. Metropolitan Area<sup>13</sup>

Ninety percent of the drinking water for the Washington D.C. area is from the Great Falls Intake and the Little Falls Intake. The water is stored and treated at the Dalecarlia Reservoir and the McMillan Reservoir. The Blue Plains Advanced

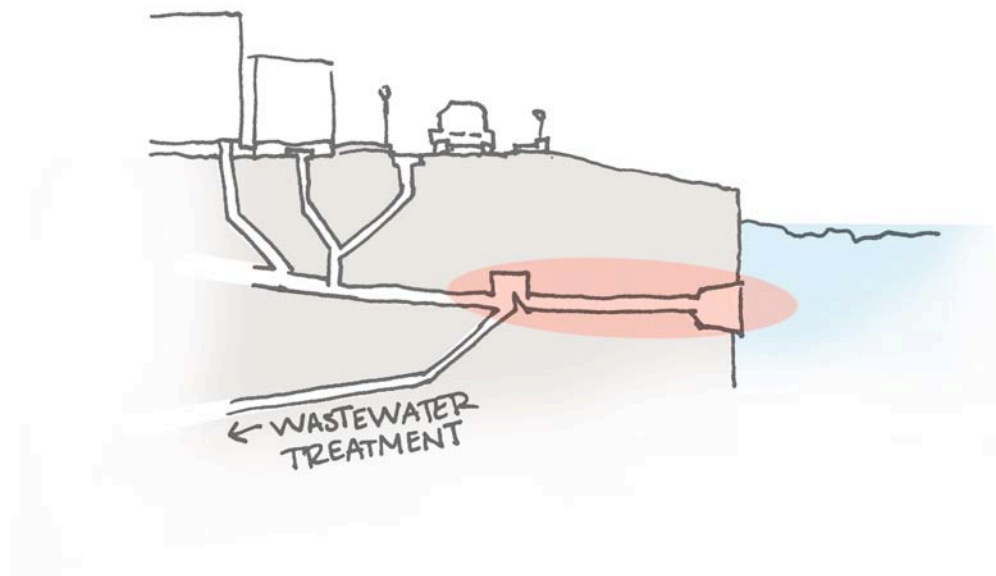
<sup>13</sup> Information from maps.google.com  
Image by author.

Wastewater Treatment Plant currently treats 330 million gallons of wastewater daily and is capable of treating 370 million gallons. DC Water operates more than 1,200 miles of pipe and 9,000 public hydrants to distribute water and operates 1,800 miles of sanitary and combined sewers.

Combined sewer outfalls (CSO) make up one third of the sewer systems in the Washington D.C. area. The combined sewer outfall carries both sanitary sewage and storm water in one piping system. When precipitation falls and reaches a certain level, the system risks backing up. To prevent raw sewage from backing up into the street and homes, it is released into the river, as seen below. As previously stated, the average annual rainfall in the area is 40 inches. In one event, if the rainfall reaches 0.4 inches it will cause raw sewage to be released into the river system. This happens often and resulted in 2,489 million gallons of raw sewage to be released into the river in 2004.<sup>14</sup>

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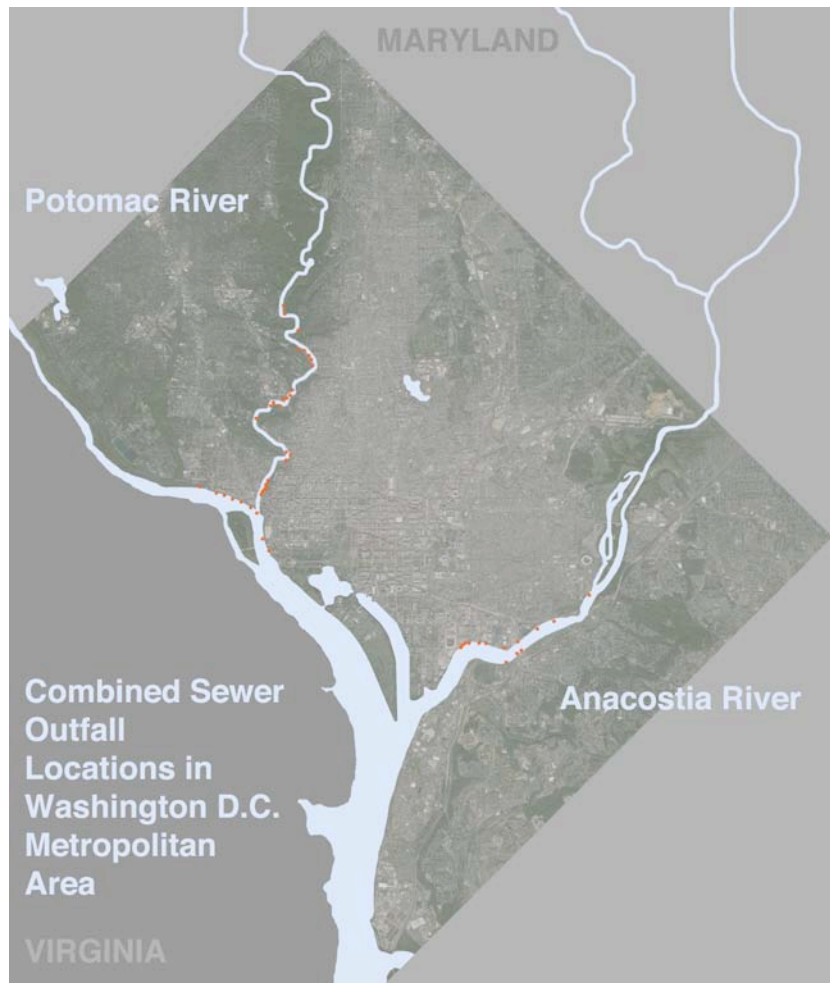
<sup>14</sup> “Combined Sewer,” DC Water. Accessed March 10, 2013.  
<http://dcwater.com/about/cip/cso.cfm>.



[Figure 5] Combined Sewer Outfall diagram<sup>15</sup>

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<sup>15</sup> Image by author.



[Figure 6] Combined Sewer Outfall locations in Washington DC Metropolitan Area<sup>16</sup>

Combined sewer outfall locations can be seen in figure 6 above. The release of raw sewage into a water body creates health issues for humans that might come into contact with the waste products directly. It also produces an excess of nutrients in the water, which fuels algal blooms. Algal blooms effectively starve the ecosystem. Light is not able to reach the vegetation in the river. The vegetation dies and is not able to

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<sup>16</sup> Information from maps.google.com and dcwater.com  
Image by author

stabilize the soil or provide habitat and food for marine life. The lack of habitat and food kill the marine life and a dead zone is created.<sup>17</sup>

In 2012 District of Columbia mayor Vincent C. Gray, with the Office of Planning (OP) and the District Department of the Environment (DDOE), released the Sustainable DC plan. This comprehensive plan addresses key issues to work towards a goal of making Washington D.C. the greenest, healthiest and most livable city in the nation. There are multiple categories addressed in this plan, including water. One of the three goals identified is to “improve the quality of waterways to standards suitable for fishing and swimming.”<sup>18</sup> One of the four ways to meet this goal is identified as “field test innovative technologies to improve river water quality.”<sup>19</sup>

### History of Site

*“So important was the river at the time that its name was chosen for the North’s first army: the Army of the Potomac.”*

*Capt. Jeff Werner<sup>20</sup>*

The series of maps in figure 7 show the changing shoreline of southern Washington D.C. from 1802 until the present. The map from 1802 shows the width of the Potomac River around Washington D.C. was more than double of what it is today. By 1825, the marshland where the Washington Monument now sits is filled in with

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<sup>17</sup> “Scientific Assessment of Hypoxia in U.S. Coastal Waters,” Committee on Environment and Natural Resources, 2010.

<sup>18</sup> Office of Planning (OP) and the District Department of the Environment (DDOE). “Sustainable DC.” The District of Columbia, mayor Vincent C. Gray, 2012.

<sup>19</sup> Ibid.

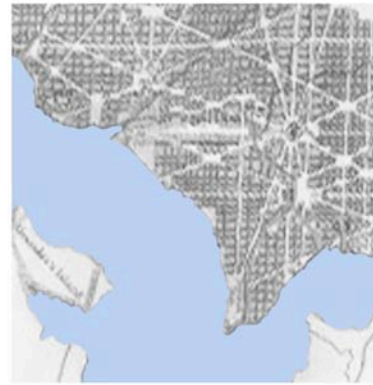
<sup>20</sup> Captain Jeff Werner. *The Potomac River and the Civil War*. Marina Life Magazine. <http://www.marinalife.com/magazine/194-the-potomac-river-and-the-civil-war>.

artificial land. Between 1825 and 1886 a significant change happens with the artificial peninsula is made from the dredged material of the river. By 2013, the area that the river in Washington D.C. takes up is reduced by about half. The nature of the shoreline before human intervention was a wetland; a space that could accommodate changes in water level and cleanse water passing through the area. The narrowing of the waterway and disruption of the edge has led to increased sedimentation and pollutants in the river. Looking at the issues that have negatively affected the waterway can help to direct future actions of cleansing and building along the waterway.





1802



1845



1886



2013

[Figure 7] Maps of the Potomac River from 1802-present day<sup>21</sup>

### Future of Site

*Rising sea level is among the most potentially catastrophic effects of human-caused climate change. Increases in sea level strengthen the destructive power of storms, and threaten to swamp major coastal cities, as well as small-island and low-lying nations. In the United States alone, more than 8 million people live in areas at risk of coastal flooding.*

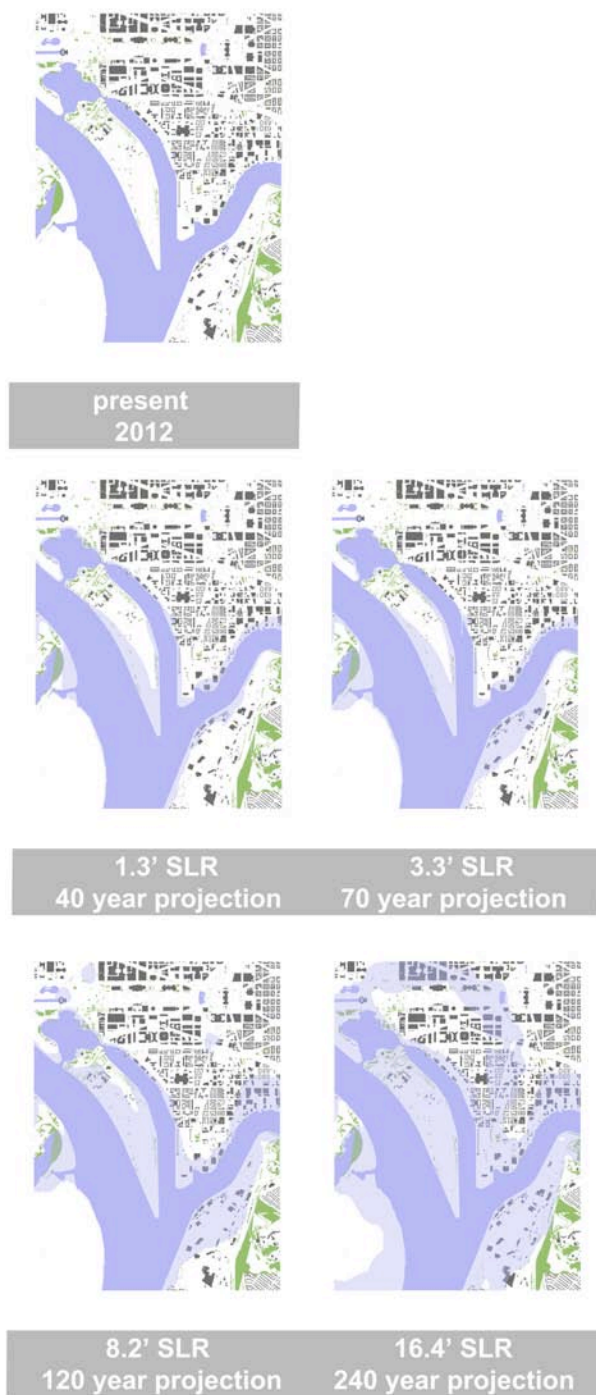
*-Wynne Parry<sup>22</sup>*

<sup>21</sup> Information compiled from David Rumsey Map Collection and maps.google.com  
Image by author.

The maps in figure 8 show the areas where the sea level is predicted to rise. The water naturally wants to flow into low-lying areas and places that it existed before human intervention. The predictions below are subject to a significant amount of fluctuation but provide some insight as to where the water will go as it rises. These diagrams are meant to reinforce the point that monitoring the water's edge and researching how we might cope with an influx of water into the city is an important job for impending change.

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<sup>22</sup> Wynne Parry, "How High Will Sea Levels Go by 2100?" [www.livescience.com](http://www.livescience.com) accessed November 13, 2013.



[Figure 8] Maps of the projected seal level rise of the Potomac <sup>23</sup>

<sup>23</sup> Information from: Bilal M. Ayyub, Haralamb G. Braileanu, and Naeem Qureshi, "Prediction and Impact of Sea Level Rise on Properties and Infrastructure of Washington D.C.," Risk Analysis Vol. 32, No. 11, 2012. Image by author.

Sea level rise and polluted water systems can be expected if no action is taken. This thesis does not directly look to strategies that address sea level rise. However, due to the interconnectedness of the water systems, environmental cleansing efforts now can cut down on environmental damage that lead to climate change.

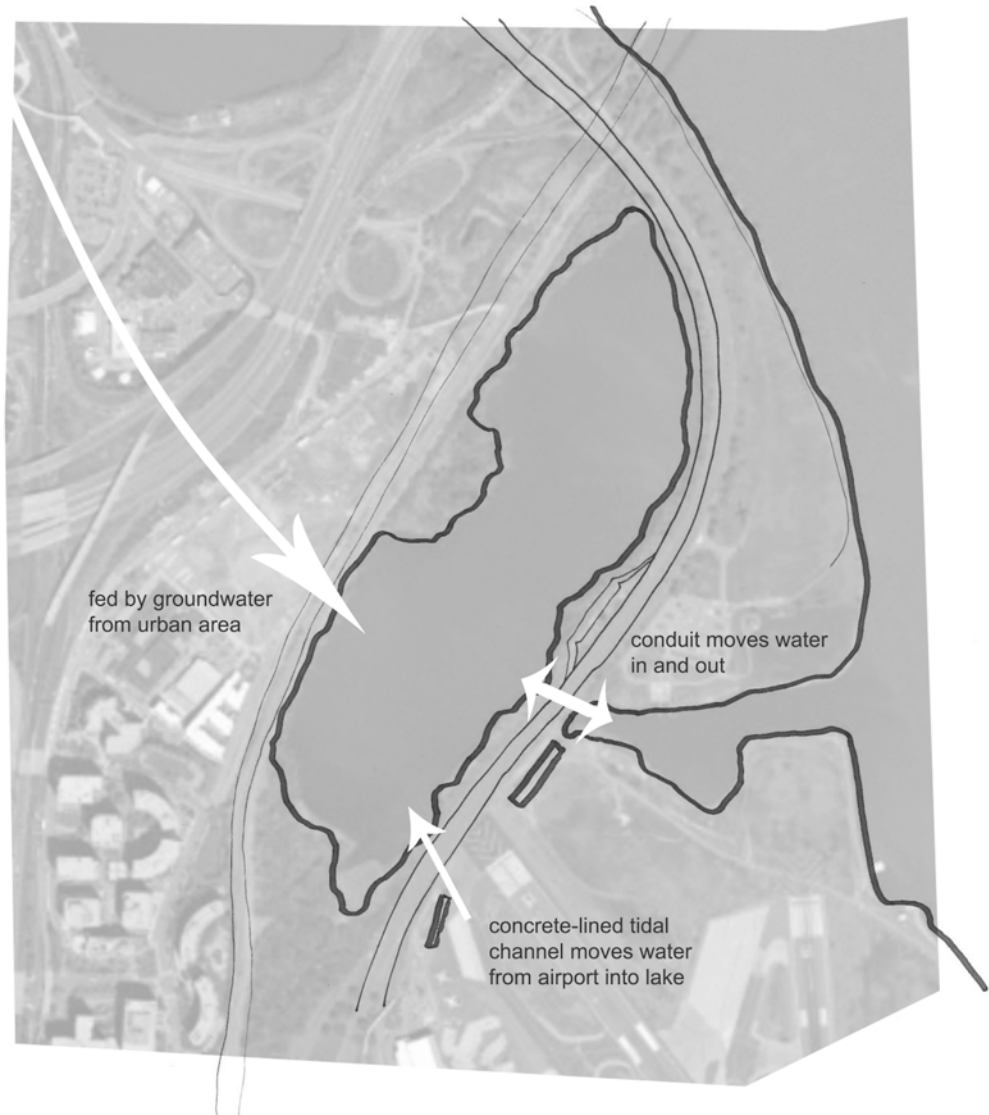
### Roaches Run Waterfowl Sanctuary

*“Sanc-tu-ary [noun] : a place of refuge and protection”*

*Merriam-Webster Dictionary*

The Roaches Run Waterfowl Sanctuary is a prime location to nest this project. As seen in figure 10, the sanctuary is in close proximity to the national mall, the symbolic heart of the country. This aligns it with the goals of working towards a healthier national river. There are views to the Washington Monument and the Capitol building and from the numerous planes leaving and arriving at the adjacent Reagan National Airport. The opportunity of a body of water in need that can help the nation’s river and connect to symbols of national pride makes this site ideal.

The Roaches Run Waterfowl Sanctuary is a 53 acre lake managed by the National Park Service. It is fed by three sources. The first is from a groundwater source located approximately one mile northwest of the lake in Arlington 15 feet below the surface. The second is the unnamed tributary that flows under runway 15 of the Ronald Reagan Washington National Airport, located to the south. The water flows under the runway and opens to form a concrete-lined tidal channel that empties into the water sanctuary. The last source the lake is fed by is the conduit that also provides the only outfall into the Potomac River.



[Figure 9] Diagram of Water Exchange<sup>24</sup>

The Potomac River water from Hains Point to the Woodrow Wilson Bridge (nearest the waterfowl sanctuary) is safe for secondary contact recreation and aesthetic enjoyment, the protection and propagation of fish, shellfish, and wildlife and navigation as defined by the District of Columbia Municipal Regulations. This section of the river is not safe for primary contact recreation or the protection of human health related to the consumption of fish and shellfish. The reason primary

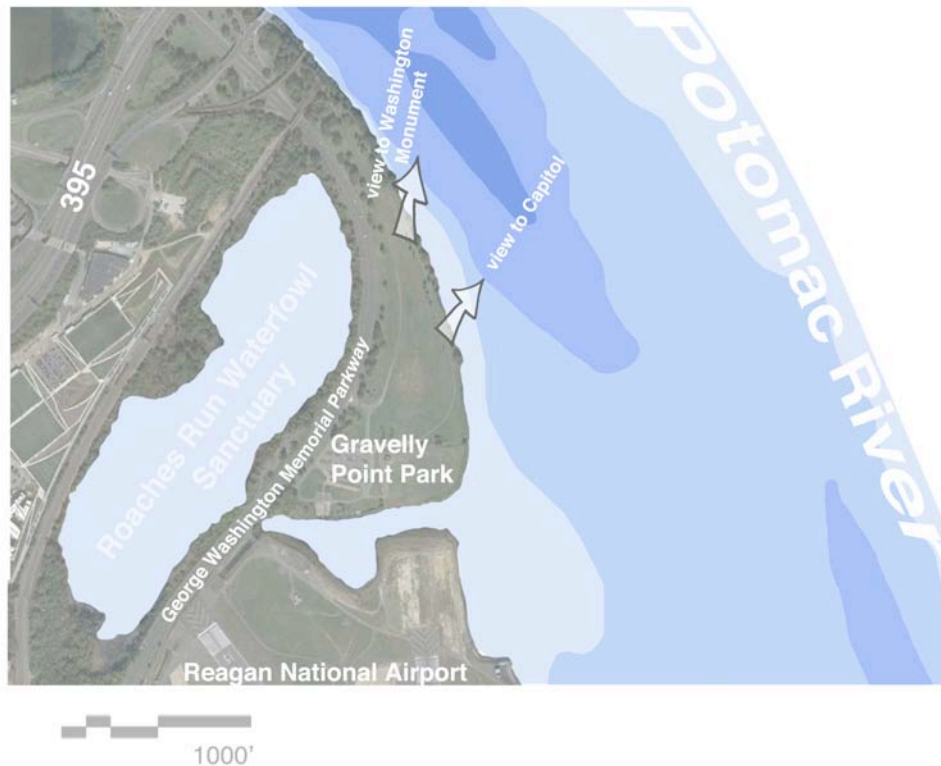
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<sup>24</sup> Image by author

contact and aquatic life consumption is advised against is primarily due to high fecal coliform bacteria levels, or excess nutrient levels. Limited sunlight due to suspended solids is also a problem.

The water quality in the waterfowl sanctuary was not been monitored since before 2008. However, it can be confidently asserted that due to urban runoff in the urbanized area around where groundwater is absorbed, the runoff from impervious sources from the airport into the unnamed tributary and the inflow from the Potomac River that the water in the waterfowl sanctuary is not fit for primary contact or aquatic life consumption.

As a part of the transformation that this project proposes, the Roaches Run Waterfowl Sanctuary will be renamed in this project and from here will be known as the Potomac Sanctuary Park.



[Figure 10] Site Diagram of Roaches Run Waterfowl Sanctuary<sup>25</sup>

### Water Quality

*“High quality water is more than the dream of the conservationist, more than a political slogan; high quality water, in the right quantity at the right place at the right time, is essential to health, recreation, and economic growth.”*

-Edmund S. Muskie, U.S. Senator<sup>26</sup>

Our water bodies are damaged in many different ways. The Potomac River is threatened by

<sup>25</sup> Map from maps.google.com  
Image by author.

<sup>26</sup> Edmund S. Muskie, *speech, March 1, 1966*. Muskie Congressional Record.  
<http://abacus.bates.edu/muskie-archives/ajcr/>

- acid drainage from coal mines
- bacteria, nutrients, and heavy metals from sewage-effluent discharges
- sediment, nutrients, and pesticides from agricultural activities
- heavy metals, organic chemicals, and high biochemical oxygen demand from industries and businesses
- sediment, nutrients, heavy metals, and organic chemicals in runoff
- degradation of groundwater by nonpoint-source contaminants, such as  
fertilizers, manure, pesticides, septic effluent, and road salt
- acidification of streams by atmospheric deposition, especially in reaches  
underlain by quartzite, sandstone, and other rocks whose composition  
cannot neutralize acidic input; and
- natural radioactivity (primarily radon) in groundwater in crystalline rocks of  
the Blue Ridge and Piedmont provinces.<sup>27</sup>

For these reasons, the Potomac River was named the most endangered in the country in 2012, according to American Rivers, an organization that protects rivers, restores damaged rivers and conserves cleans water for people and nature.<sup>28</sup>

The water quality is also negatively affected by dredging efforts. The lack of a natural wetland allows sediment to quickly accumulate on the riverbed. This prohibits ship passage so the Army Corps of Engineers removes this sediment annually. This

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<sup>27</sup> “National Water-Quality Assessment—Potomac River Basin,” USGS, accessed November 9, 2013, <http://md.water.usgs.gov/publications/ofr-91-157/ofr-91-157.html>.

<sup>28</sup> “American Rivers Names America’s Most Endangered Rivers of 2012,” American Rivers, accessed November 10, 2013, <http://www.americanrivers.org/newsroom/press-releases/american-rivers-names-americas-most-endangered-rivers-of-2012/>.



effort disturbs wildlife habitats such as bay grass root systems and oyster beds on the river floor. The presence of indigenous wildlife is important to maintain the water quality.

## Chapter 3: Natural Cleansing Systems

### Introduction

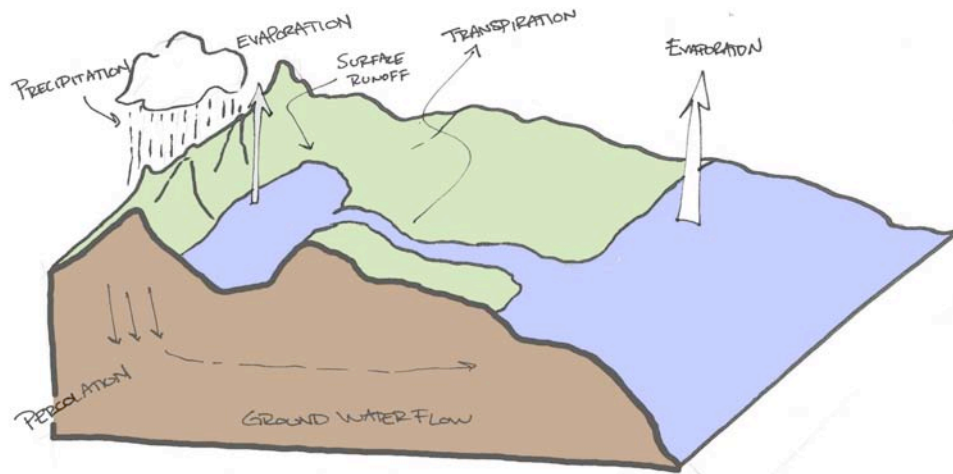
*“Water is the driving force of all nature.”*

*-Leonardo da Vinci<sup>29</sup>*

The natural hydrological system, figure 11, provides a starting point in examining how to naturally cleanse the water. Understanding the exact way nature cleanses water and the cycle works can propose strategies for human made systems.

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<sup>29</sup> Leonardo da Vinci, *Water – Nature’s Driving Force*.  
<http://www.theleonardo.org/exhibits/discover/past-exhibit/water/>

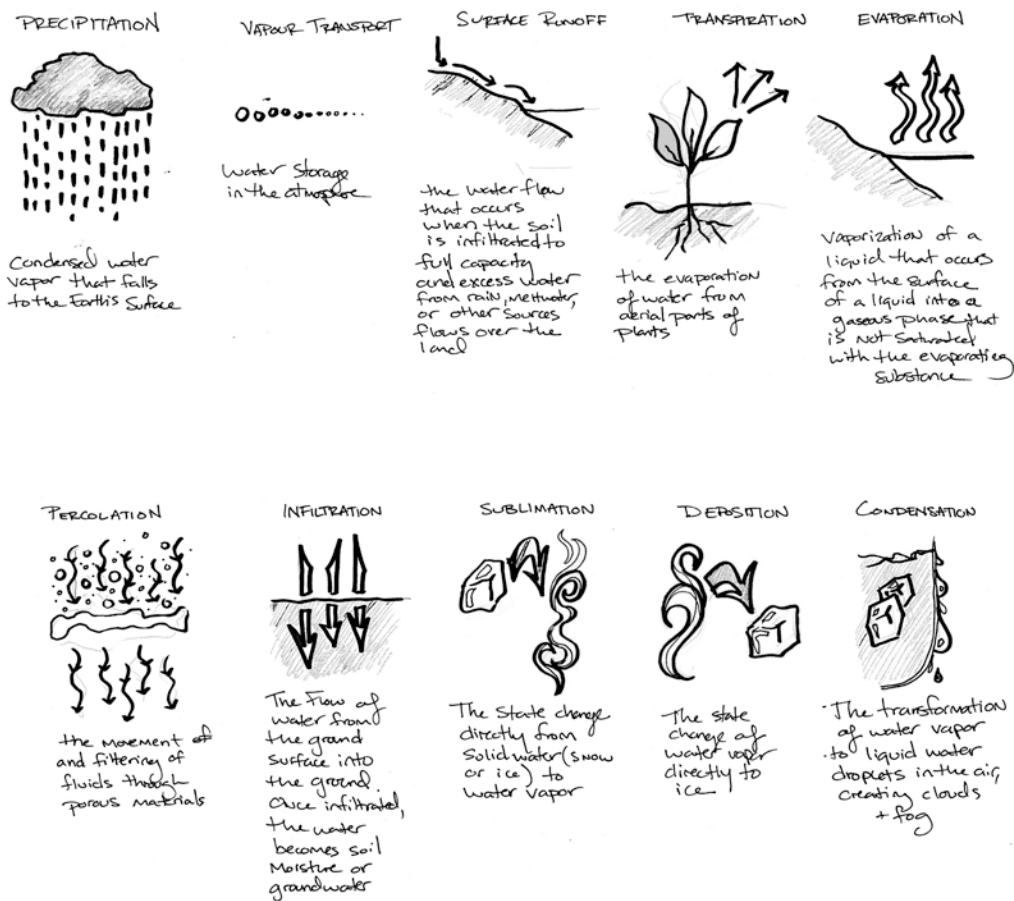


[Figure 11] Diagram of Hydrologic Cycle <sup>30</sup>

By breaking the system down into its component parts, each cleansing strategy can be understood. The ten diagrams in figure 12 below illustrate the different ways water is moved through the environment and cleansed in the process.

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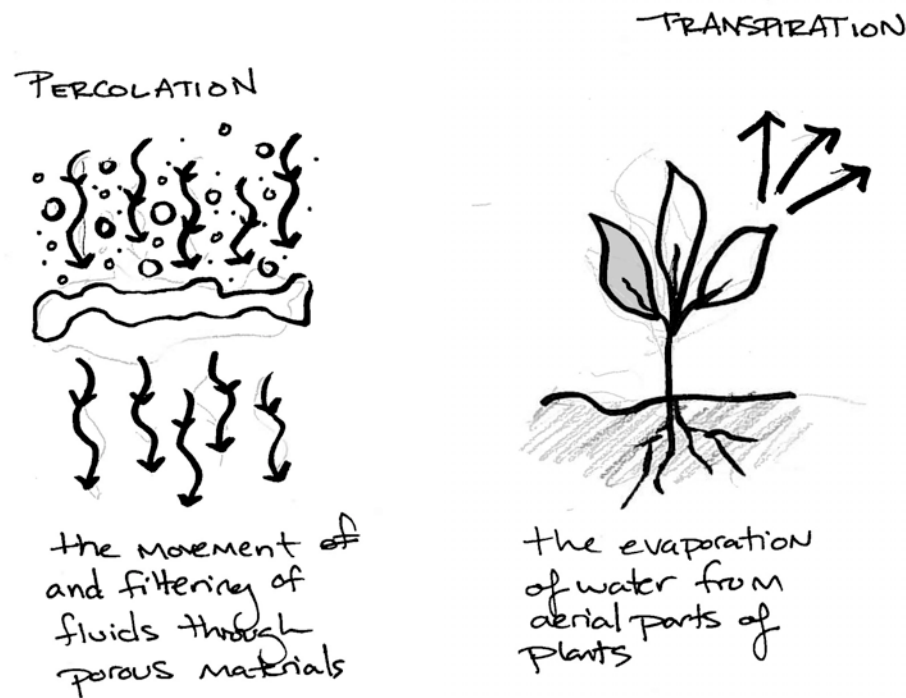
<sup>30</sup> Image by author.



[Figure 12] Diagram of Components of Hydrologic Cycle<sup>31</sup>

The main cleansing needs addressed in this specific project are the removal of suspended solids and the removal of excess nutrients from agricultural runoff and combined sewer outfalls through filtration and nutrient reuptake. The percolation that happens in nature is the basis for filtration techniques. Transpiration moves nutrients that are desirable to plants, and undesirable to the Potomac River now (such as excess nitrogen, nitrates, phosphorous and ammonia) through the vegetation and releases it.

<sup>31</sup> Image by author.



[Figure 13] Diagram of Percolation and Transpiration<sup>32</sup>

Natural systems are the basis of study. We can construct systems that learn from nature and help it to perform in a way that allows humans to coexist in a responsible way with nature.

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<sup>32</sup> Images by author.

## Filtration

*“Wetlands...are among the earth’s greatest natural assets...mankind’s waterlogged wealth” -*

*Edward Maltby*<sup>33</sup>

Wetlands are ecological zones that exist where land meets water. This environment was once much more plentiful along the shorelines in Washington D.C. Wetlands are characterized by the presence of three substances: water, soil and vegetation. Wetlands purify and filter water that passes through them. They improve water quality by transforming chemicals, trapping sediment and preventing erosion. The dense root systems stabilize the shoreline. Eroded sediments have a negative impact downstream. The sediment causes cloudiness in the water that can smother vegetation and the larvae of fish and amphibians. The ability of wetland to release excess water slowly prevents surges and flooding downstream.<sup>34</sup> Wetlands function as nurseries for myriad species. Invertebrates, fish, amphibian, avian and mammalian species raise their young in these spaces that provide shelter and nutrients.

This project will propose constructing wetland spaces on the majority of shoreline in the current site boundaries. A similar technique is implemented in the form of a smart street.

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<sup>33</sup> Edward Maltby, *Waterlogged Wealth: Why Waste the World’s Wet Places* (Arlington, VA: AgriBookstore, 1986)

<sup>34</sup> A. van der Valk. *The Biology of Freshwater Wetlands*. Oxford: Oxford University Press, 2006.



[Figure 14] Diagram of Smart Street<sup>35</sup>

A smart street (figure 14) aims to slow storm water runoff by implementing pervious paving instead of asphalt and directs runoff into swales that contain native, water-tolerant plants to slowly absorb and cleanse the water before it enters the water table and enters the Potomac River. The smart street sections will border the entrance and exit to the parking lot. This is a practical application on the site and also serves to showcase a system that can be implemented on many streets. A rain garden is another technique that directs water on a site to a specific lower elevation that contains water-tolerant plants to slowly absorb and cleanse water. A rain garden will be present adjacent to the structure. The rain garden is something that individuals can implement on their own property. Instructions will be available in the building and appropriate plants available for sale.

A blue roof system will use the process of filtration through vegetation to cleanse water. The folded plate structure of the roof directs rainwater into a glass

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<sup>35</sup> Image by author.

structure between the roof and floor. The water is directed to the vegetation at the bottom of the showcase structure where it is slowly cleansed by filtration and nutrient reuptake. The cleansed water is then released back into the water body.

*“He was a bold man that first ate an oyster.”*

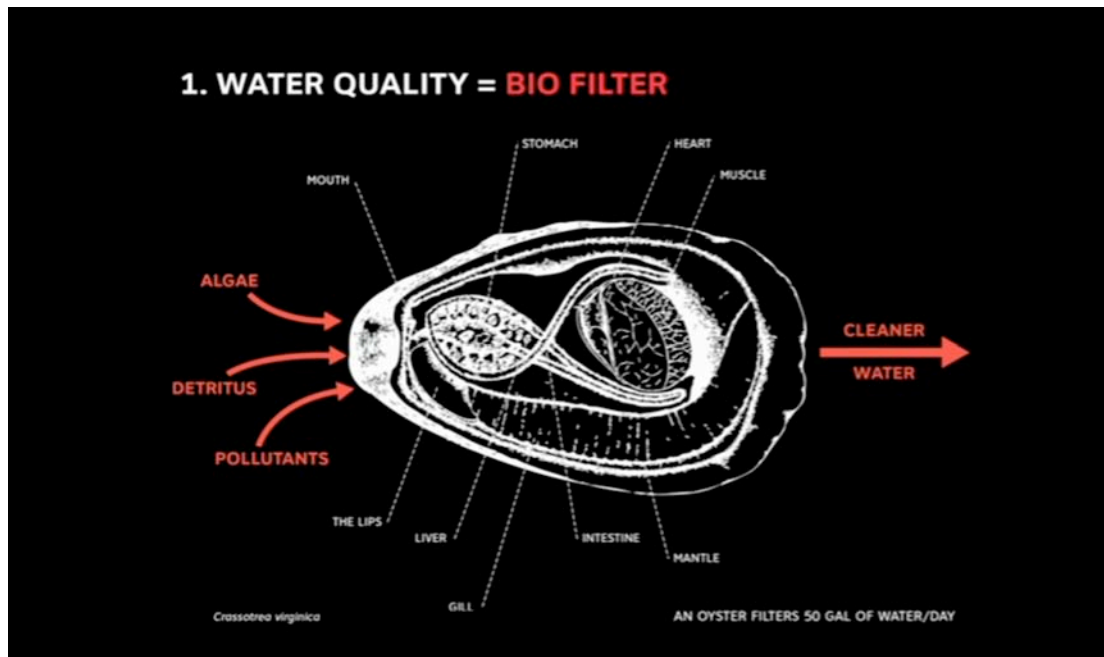
*—Jonathan Swift<sup>36</sup>*

The Eastern Oyster is a filter-feeding bivalve mollusk. Oysters flourished in the Chesapeake Bay in the past but due to human pollution, over-fishing and disease their population has drastically decreased. Oysters feed on plankton and detritus that they get by opening their shells and pumping water through their gills. This traps the food and pumps filtered water back into the system. One oyster can filter more than 50 gallons of water in 24 hours.<sup>37</sup> Oysters beds create habitats for a variety of different species making the oyster a filtration device and a key ingredient to restore the ecosystem in the Potomac River.

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<sup>36</sup> Jonathan Swift, quote. <http://www.goodreads.com/quotes/8907-he-was-a-bold-man-that-first-ate-an-oyster>

<sup>37</sup> Chesapeake Bay Program. “Eastern Oyster,” *About the Bay*. Accessed November 11, 2013.



[Figure 15] Anatomy of an Oyster<sup>38</sup>

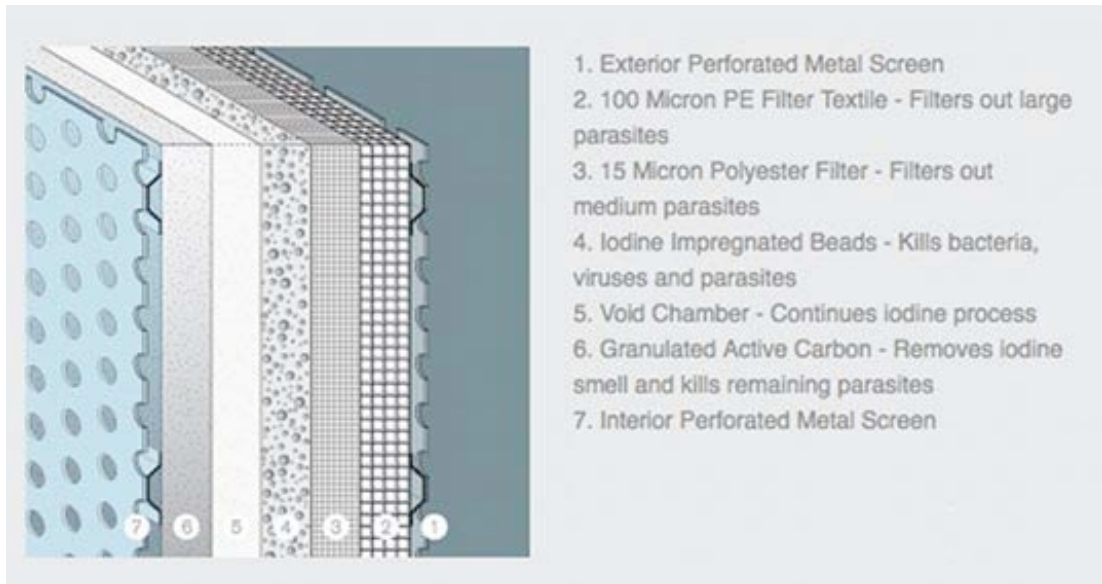
*“Fil-ter [verb] : pass through a device to remove unwanted material.”*

*—Merriam-Webster Dictionary*

Filtration is accomplished with non-chemical materials. By putting a section of materials (figure 16) in a water body it can act as a strainer. As adopted from the precedent +Pool, discussed in Chapter 4, the material section is assembled as identified in the image below.

<sup>38</sup> Image from Kate Orff TED talk





[Figure 16] Section Diagram of + Pool Wall Section<sup>39</sup>

### Nutrient Reuptake

Quaking Bogs are naturally occurring mats of floating vegetation that can be present in wetter parts of valley bogs. At approximately two feet thick, they usually support sphagnum moss anchored by sedges (figure 17).

<sup>39</sup> Family and PlayLab, + POOL, Tile by Tile, accessed September 6, 2013.  
<http://www.kickstarter.com/projects/694835844/pool-tile-by-tile>



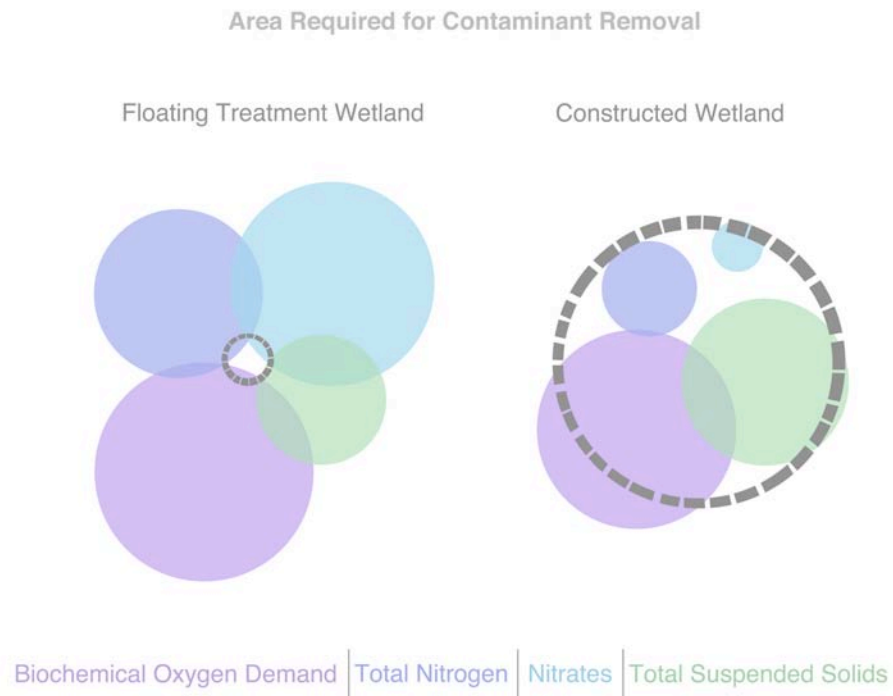
[Figure 17] Quaking Bog photograph <sup>40</sup>

This natural piece of the landscape inspired a company called Floating Island International (FII) using BioHaven technology. The research produced by FII inspires my own design for a floating treatment wetland that is incorporated into this site to cleanse through nutrient reuptake.

Many case studies were conducted to test the cleansing ability of the floating treatment wetlands. The following diagram represents specific information gathered from research compiled at Rehberg Ranch Residential Subdivision in Billings, Montana by FII.

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<sup>40</sup> Quaking Bog on Duck Lake, 2006 by Noah Elhardt



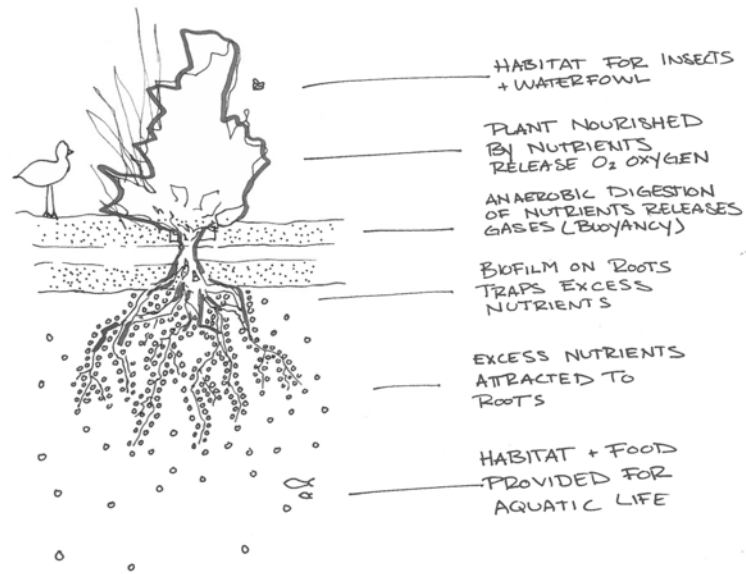
[Figure 18] Area Required for Contaminant Removal Diagram <sup>41</sup>

Although constructed wetlands serve an important purpose on the shoreline, their cleansing power can be amplified if the vegetation is moved out into the water. The dotted line in the diagram in figure 18 represents the area required for a floating treatment wetland versus constructed wetlands. A floating treatment wetland takes up only 20% of the area of a comparable constructed wetland is extremely efficient. In this smaller area, the nitrogen, nitrates and suspended solids are removed in comparable or larger amounts.

This is accomplished by the process of nutrient reuptake, illustrated below in figure 19, inspired by the natural hydrologic process of transpiration.

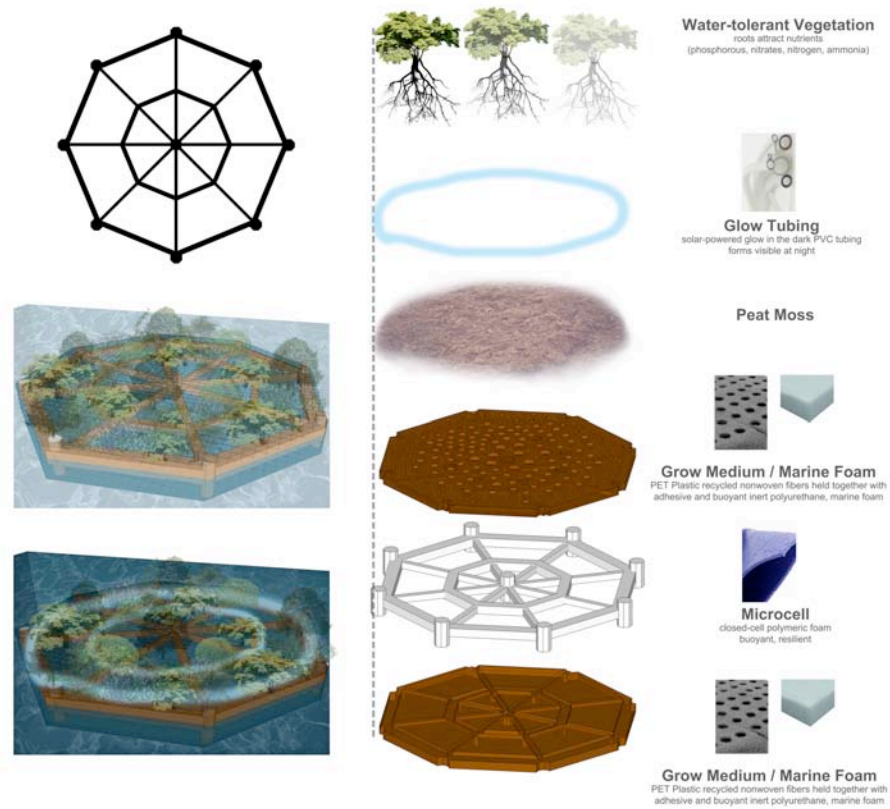
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<sup>41</sup> Information from Floating Island International. Image by author.



[Figure 19] Nutrient Reuptake Diagram

Figure 20 illustrates the component parts of the floating treatment wetland and how cleansing is accomplished.



[Figure 20] Structure of Floating Treatment Wetland <sup>42</sup>



[Figure 21] Floating Treatment Wetland Section

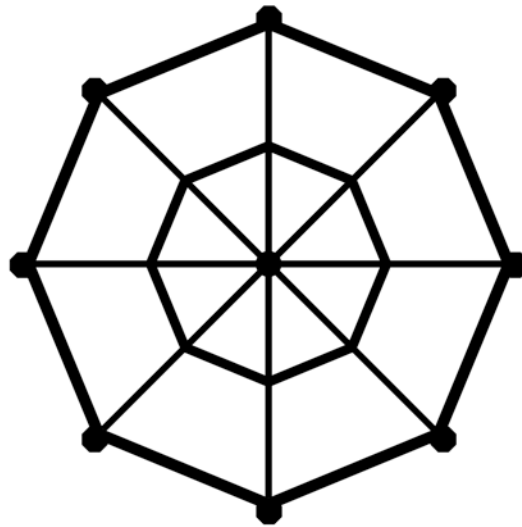
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<sup>42</sup> Image by author.

<sup>43</sup> Image by author.



The structure of the FTW (figure 21) is provided by closed-cell polymeric foam called Microcell that is buoyant and resilient. It is inexpensive and resistant to chemical breakdown.<sup>44</sup> The Microcell is formed into a radial arrangement that mimics the structure of the giant lily pad. The scaffolding of the Giant Lily Pad makes the leaf platters strong, rigid, buoyant, and light.<sup>45</sup> The veins are taller than they are wide, allowing the strong axis to support weight in the x dimension. Figure 22 is a plan view is an original design developed for this project.



[Figure 22] Diagram of Floating Treatment Wetland Structure<sup>46</sup>

The Microcell structure is sandwiched between a grow medium composed of PET Plastic recycled nonwoven fibers held together with adhesive and buoyant inert polyurethane marine foam. This material combination allows for a strong matrix to

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<sup>44</sup> Sentinel Products Corp. *Microcell* <http://library.materialconnexion.com.proxy-um.researchport.umd.edu/ProductPage.aspx?&Keywords=microcell&Attributes=&Category=&Country=&Manufacturer=&Tag=&MC=199401&Lang=en&ProdID=&PageNum=1&ItemsPerPage=20&SearchDisp=0>

<sup>45</sup> Attenborough, D. *The Private Life of Plants: A Natural History of Plant Behavior*. London: BBC Books, 1995.

<sup>46</sup> Image by author.

support vegetation while also providing buoyancy. The matrix on the anterior of the FTW is dotted with two-inch deep wells to provide a place for vegetation to take root. A thin layer of Peat Moss covers these wells to give seedlings nutrients before their roots are able to reach the water. Solar-powered Lunabrite tubing provides a blue light at night to add interest and visibility from a distance away. The glowing substance is encased in PVC tubing making it appropriate for outdoor and marine use. Finally, water-tolerant native vegetation species are planted on the FTW. Once the roots reach the water, they derive nutrition from the excess amount of nutrients in the water on site.

As the plants mature and become larger, the roots aid in the extra buoyancy needed. Buoyancy is achieved through the entrapment of gases in the roots generated during anaerobic metabolism of organic deposits. The roots attract the nutrients because they are covered in biofilm. Biofilm is a group of microorganisms in which cells adhere to each other on a surface. The cells are embedded within a self-produced matrix called Extracellular Polymeric Substance or EPS, known in the vernacular as slime. Biofilm is found in many applications in nature. The cells have the ability to program themselves to attract certain nutrients. The nutrients desired by the biofilm, and the vegetation on a FTW are the excess nutrients that need to be removed in the Potomac River system. The roots, figure 23, provide food, habitat and nursery for fish and amphibians. The FTW above the water's surface provide habitat for insects, amphibians, birds and other species to restore the once present natural ecosystem of the area.



[Figure 23] View of Floating Treatment Wetland from Underwater<sup>47</sup>

#### Other Site Strategies to Aid in Water Cleansing

A green roof is present to provide both climate mediation and water filtration but also provides an enhanced and symbolically appropriate appearance for the center.. Cleansing water at different scales is addressed in this structure. Absorbent W, manufactured by Absorption Corp. is an oil-absorbing cellulose fiber. The hydrophobic material absorbs oil while repelling water. After saturated with oil, the

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<sup>47</sup> Image by author.



material still floats. The material is produced with discard products from paper production.<sup>48</sup> The site of thesis project allows for separate testing ponds and research space to work with new materials like Absorbent W (figure 24) to study techniques to clean oil spills.



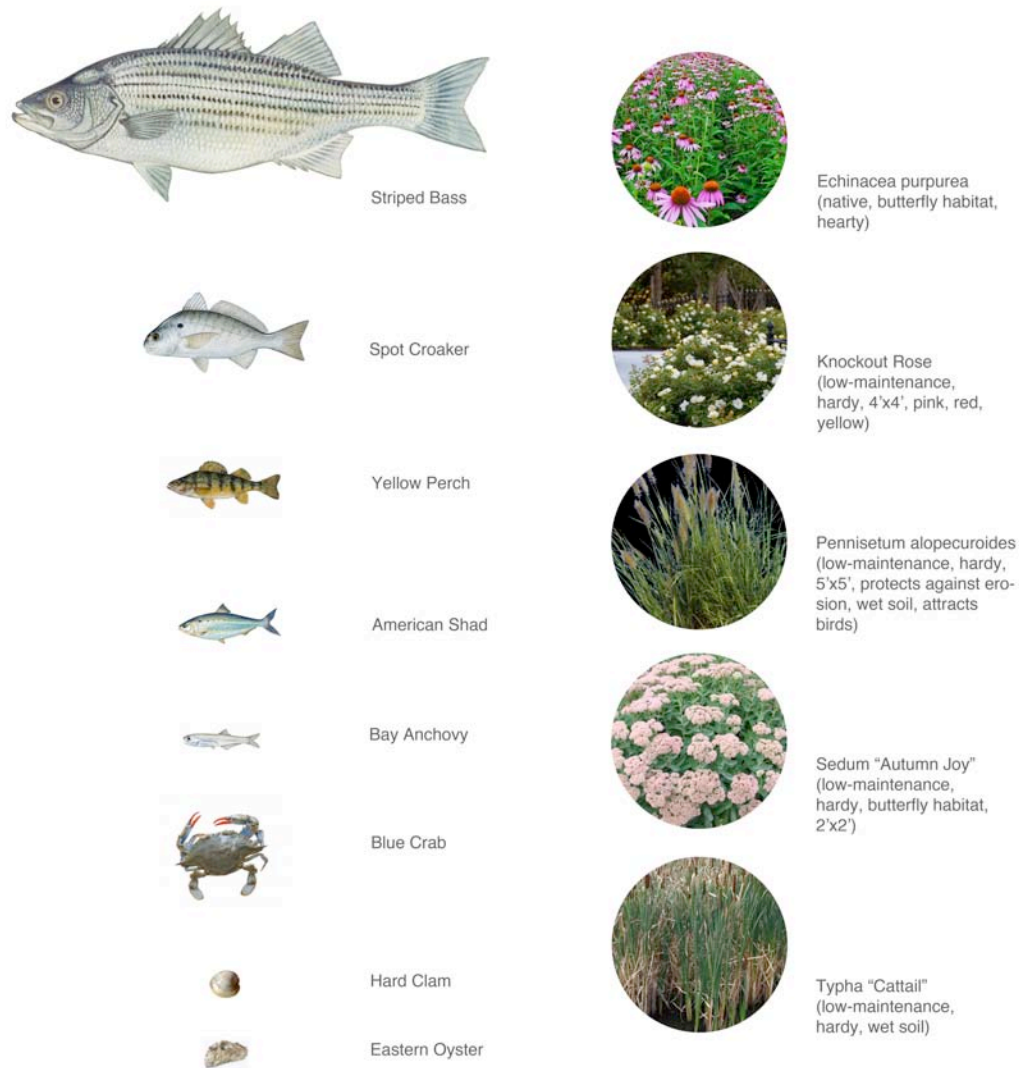
[Figure 24] Absorbent W photograph

The introduction of the filter-feeding oyster lays the foundation to introduce and rehabilitate indigenous wildlife populations. The structure and associated site

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<sup>48</sup> Material ConneXion database. *Absorbent W*. Accessed October 5, 2013. <http://library.materialconnexion.com/ProductPage.aspx?&Keywords=&Attributes=&Category=&Country=&Manufacturer=&Tag=&MC=656401&Lang=en&ProdID=&PageNum=1&ItemsPerPage=20&SearchDisp=0>

strategies kick starts the cleansing of the water. The systems put in place aim to reestablish the ecosystem so that the system can be self-sustaining. Figure 25 shows examples of native aquatic species and water-tolerant vegetation, respectively.<sup>49</sup>



[Figure 25] Native Fish and Vegetation Species<sup>50</sup>

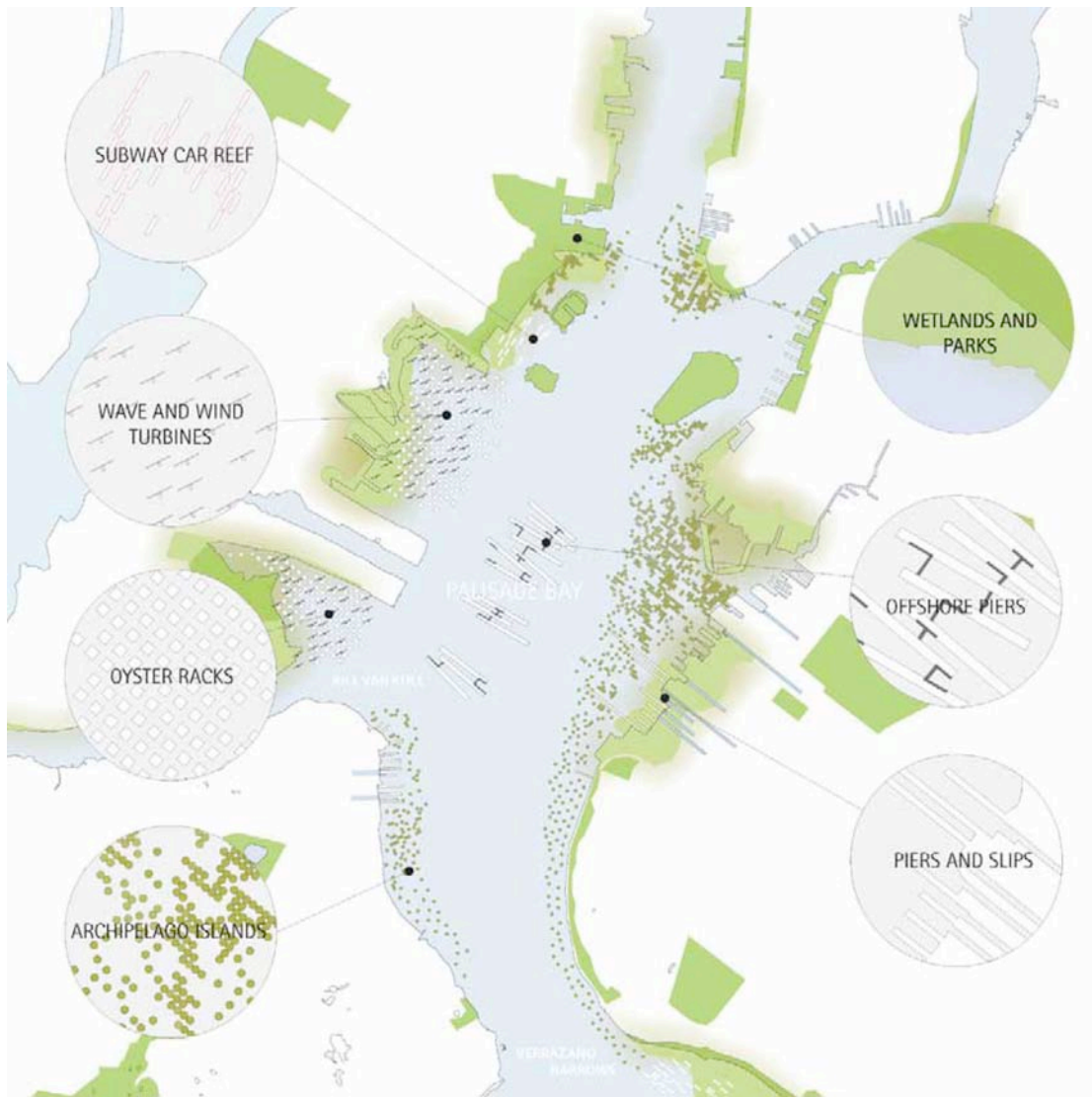
<sup>49</sup> Chesapeake Bay Program. "Native Species," *About the Bay*. Retrieved November 11, 2013. <http://www.chesapeakebay.net/fieldguide/critter>.

<sup>50</sup> Image by author.

## Chapter 4: Precedents

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### On the Water: Palisade Bay



[Figure 26] On the Water: Palisade Bay<sup>51</sup>

<sup>51</sup> Guy Nordenson, *On the Water: Palisade Bay*. New York: MoMA, 2010.

The study of Palisade Bay (figure 26) by Guy Nordenson, Catherine Seavitt and Adam Yarinsky with Stephen Cassell, Lizzie Hodges, Marianne Koch, James Smith, and Michael Tantala in 2007 aimed to dampen powerful storm currents as well as encourage the development of new estuarine habitats, revitalize the waterfront with porous parks for recreation and community development and enact zoning formulae that adapt for resilience to future natural disasters.<sup>52</sup> This study led to the *Rising Currents* Exhibition at the Museum of Modern Art in 2010. This precedent is relevant because it explores different possibilities of soft edges, that can manage water by allowing it into the city rather than building a wall, hard edge, to keep it out.

#### New Urban Ground



[Figure 27] New Urban Ground<sup>53</sup>

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<sup>52</sup> Nordenson, Guy, et al. *On The Water: Palisade Bay*, 2007

<sup>53</sup> Stephen Cassell, Susannah C. Drake and Adam Yarinsky, *New Urban Ground*. From *Rising Currents* Exhibition at MoMA, 2010.

Figure 27 is an image of Manhattan from the New Urban Ground project proposed for the Rising Currents Exhibition at MoMA in 2010 represents the basic ideology behind this project. The softening of city edges allows water to come into cities in a more controlled way. By designating wetland parks, water has a place to go, rather than rushing into structure and on roads. The softer city edges made up of wetlands act as a sponge and absorb storm water. The water is cleansed as it works its way through the wetland and slowly released back into the water cycle. It also offers more opportunities for green space in the city and recreation. The more natural edge provides resiliency and the ability to cleanse water and slow the runoff from storms.

#### +Pool

First proposed by Dong-Ping Wong of Family and Archie Lee Coates IV and Jeffrey Franklin of PlayLab, this precedent is especially applicable to this project. The second round of testing (building a scaled down version of the final project) was completed in August 2013. This project sets goals similar to my own: cleansing of a water body through filtration. The placement of the project, in the East River, near the Brooklyn Bridge in New York City (figure 28 and 29) communicates with the public through the possibility of a swimmable river. The project was funded in a way that I would like to propose for my own project. The second phase (costing \$250,000) was crowd-funded completely on kickstarter.com and has become the largest civic project funded on the website. In return for the donation, the donor's name is engraved on a tile used to line the pool (figure 30). The project was actually over-funded in the 30 days that it was on the website. The involvement of the public in a creative manner makes the project viable and also creates excitement for the work.



The success thus far of +Pool strengthens this thesis by proving there is a tangible public interest in cleaning our waterways. The inclusion of ARUP to help engineer the project also provides viable information in non-chemical filtration systems and floating technology. The idea of public interest design is present in the +Pool and is also a part of this thesis. If people are given the chance to have fun (swim, walk, fish, etc.) on the river or water body, they become invested in it. This project will act as a catalyst to prevent pollution from entering the water system and also to more extensively cleanse the water.<sup>54</sup>

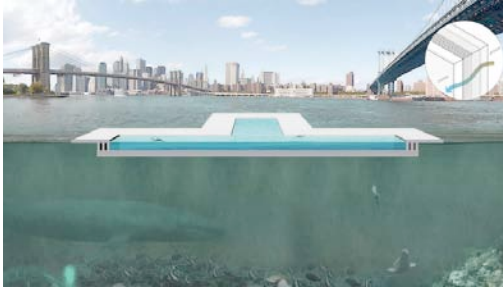


[Figure 28] + Pool in East River<sup>55</sup>

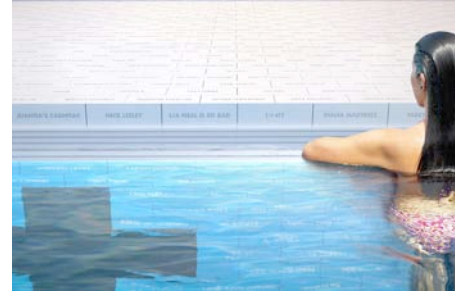
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<sup>54</sup> <http://www.pluspool.org/pool>

<sup>55</sup> *ibid.*



[Figure 29] + Pool section<sup>56</sup>



[Figure 30] + Pool detail<sup>57</sup>

### Lady Landfill Skyscraper

The Lady Landfill Skyscraper by Laureate functions mainly to remove non-degradable materials from the water. The goal is to use the collected material as an energy source or to recycle it. The materials are harvested from the Great Pacific Garbage Patch, an amalgamation of garbage in the Pacific Ocean weighing approximately 3.5 million tons and about 30 meters deep. The parts of the skyscraper that emerge from the water are used for housing and recreation. This is an important precedent because the program combines a space for recreation but primarily cleanses the water in the Pacific. The scale is much larger than a river-based structure but the idea is similar.

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<sup>56</sup> *ibid.*

<sup>57</sup> *ibid.*



[Figure 31] Lady Landfill Skyscraper Underwater Perspective <sup>58</sup>

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<sup>58</sup> Furuto , Alison. "Jacques Rougerie Foundation Competition Winners" 17 Jan 2013. ArchDaily. Accessed 29 Apr 2013. <<http://www.archdaily.com/319060>>



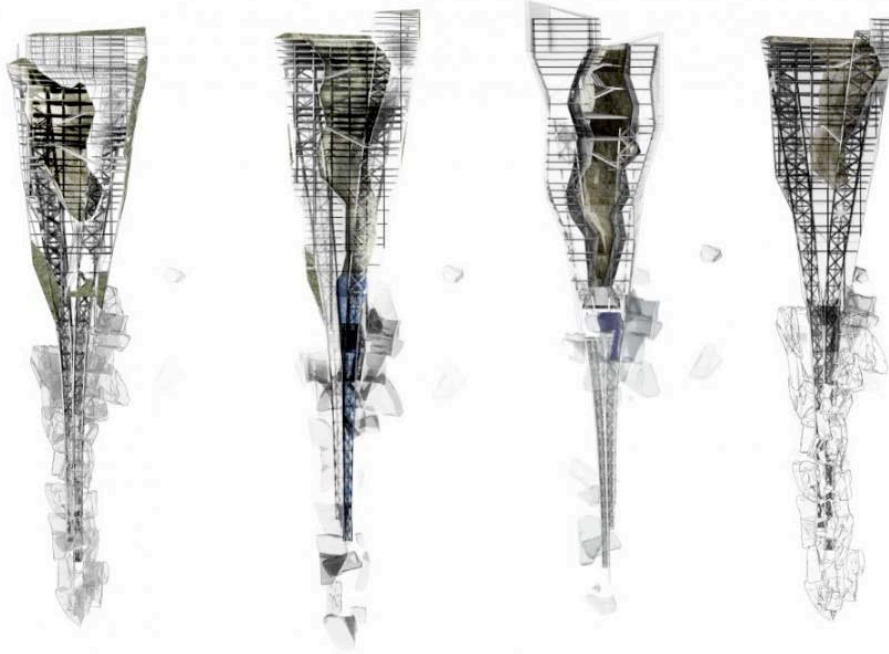


[Figure 32] Lady Landfill Skyscraper Above Water Perspective<sup>59</sup>

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<sup>59</sup> Ibid.

cross sections  
cross sections  
cross sections



[Figure 33] Lady Landfill Skyscraper Sections <sup>60</sup>

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<sup>60</sup> Ibid.

## High Line<sup>61</sup>



[Figure 34] High Line photograph<sup>62</sup>

The High Line project, designed collaboratively by James Corner Field Operations, Diller Scofidio + Renfro, planting designer Piet Oudolf and structural engineering firms Robert Silman Associates and Buro Happold provides technical insight that is useful in this thesis. The project team investigated specific planting types that would create (or recreate) needed habitats for birds and insects. The gradual absorption of rainwater and storm water into the natural water system drastically helps reduce pollution in waterways. The High Line uses the following breakdown of materials to aid in drainage and water retention:

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<sup>61</sup> Travel to the High Line project is thanks to a research grant from the University of Maryland

<sup>62</sup> Photograph by author.

**Top layer of gravel mulch to aid in water retention and prevent soil erosion due to wind**

**Lay of finer, more nutrient-rich topsoil**

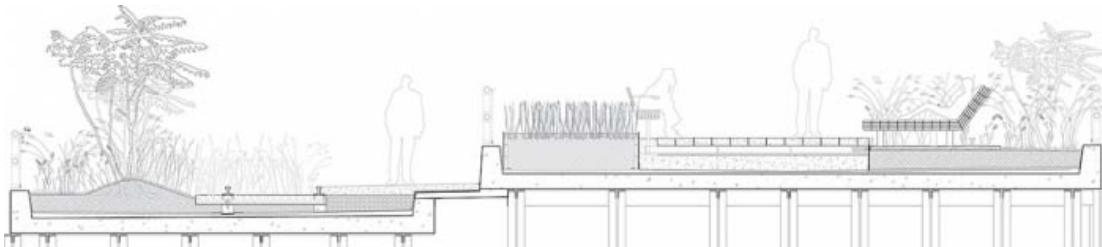
**Layer of coarser, clay-based subsoil**

**Woven filter fabric to keep soil particles from clogging drains**

**Layer of crushed pea-gravel to act as a buffer, regulating the speed at which water drains**

**Perforated black plastic “egg-crate” drainage panel to provide water retention, drainage, and aeration to the soil**

[Figure 35] high Line Section Diagram of Materials <sup>63</sup>



[Figure 36] High Line Section Drawing <sup>64</sup>

Plantings on the High Line were inspired by the species that grew there during the time it was abandoned. Plant species used were locally grown and are native to the area to reduce maintenance needs and to increase hardiness. Seen above is the habitat that was created and is thriving.

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<sup>63</sup> image by author.

<sup>64</sup> [friendsofthehighline.org](http://friendsofthehighline.org)

Peter Jay Sharp Boathouse / Sherman Creek Center<sup>65</sup>

The Peter Jay Sharp Boathouse (figure 37) is a structure built in NYC thanks to the New York Restoration Project. This non-profit organization is cleaning up the river and working to build the Sherman Creek Center, which will educate the public about water systems in the city.



[Figure 37] Peter Jay Sharp Boathouse photograph<sup>66</sup>

The transition between the stable land and floating boathouse (figure 38) was of particular interest for this project. The floating dock is an element that will be included in this project. It was important to experience this and see if it is too uncomfortable of an experience for the public or if it is acceptable. Walking over the floating dock was not uncomfortable but provided a feeling of connection to the

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<sup>65</sup> Travel to the Peter Jay Sharp Boathouse is thanks to a research grant from the University of Maryland

<sup>66</sup> Photograph by author.



water. The ten-foot width of the dock is important to give the person walking on it a feeling of security.



[Figure 38] Peter Jay Sharp Boathouse dock photograph <sup>67</sup>

The detail (figure 39) of how the walkway is kept in the same position on the river but allowed to move up and down in response to sea level change is also important.

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<sup>67</sup> Photography by author.



[Figure 39] Peter Jay Sharp Boathouse Dock Detail photograph <sup>68</sup>

The Sherman Creek Center aims to provide education and research on water systems and includes a few different program elements. The center is not yet complete but some elements on the site are in place. Figure 40 shows a wetland area and a walkway that snakes over the spongy land.

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<sup>68</sup> Photography by author.



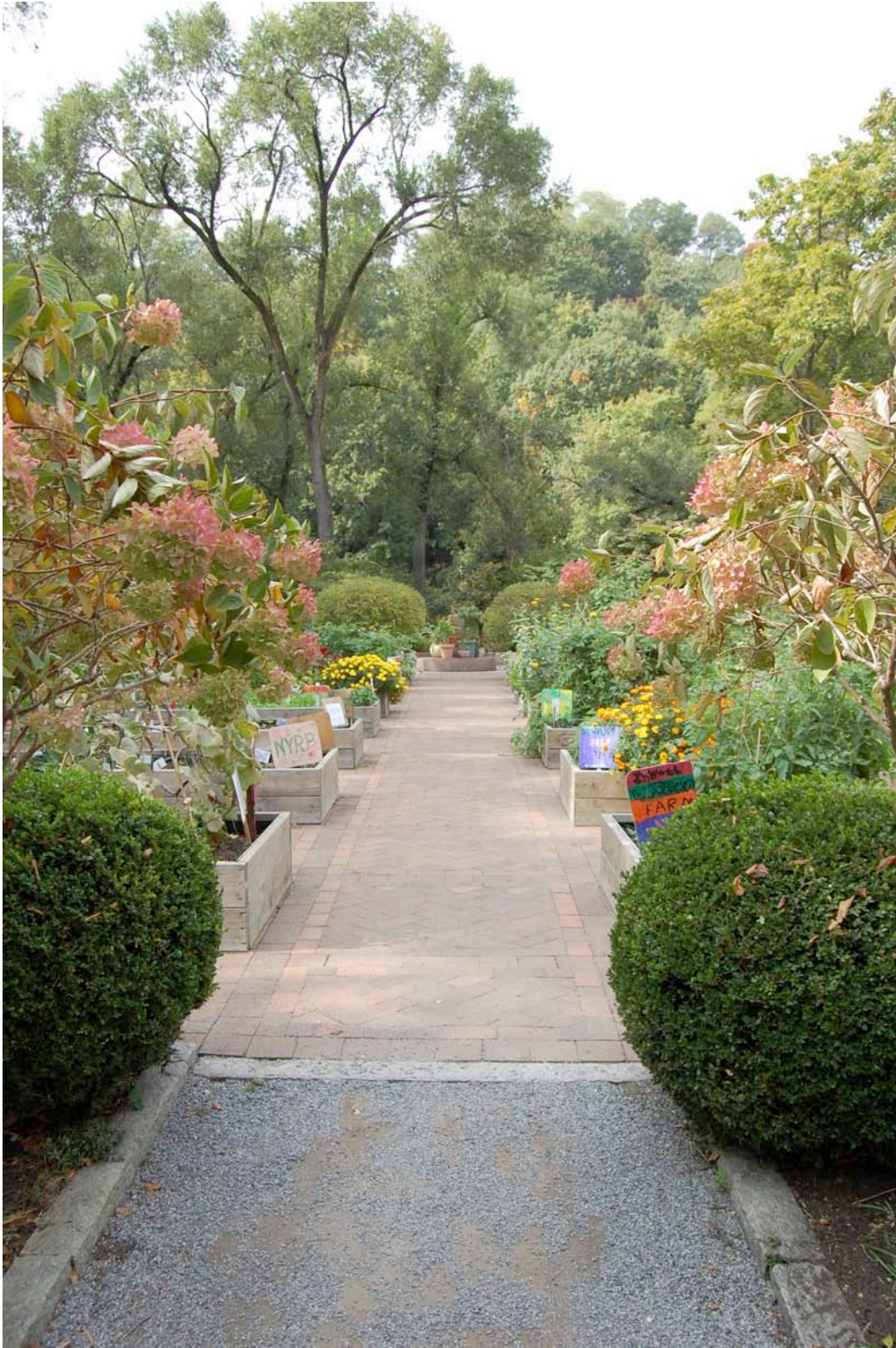
[Figure 40] Sherman Creek Center Wetland photograph <sup>69</sup>

There is an elementary school adjacent to the boathouse and future location of the Sherman Creek Center. The elementary school students and community members maintain and harvest the crops cultivated here (figure 41) for educational purposes.

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<sup>69</sup> Photograph by author.





[Figure 41] Sherman Creek Center Education Garden photograph<sup>70</sup>

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<sup>70</sup> Photograph by author.

### App-grading Wet Slums

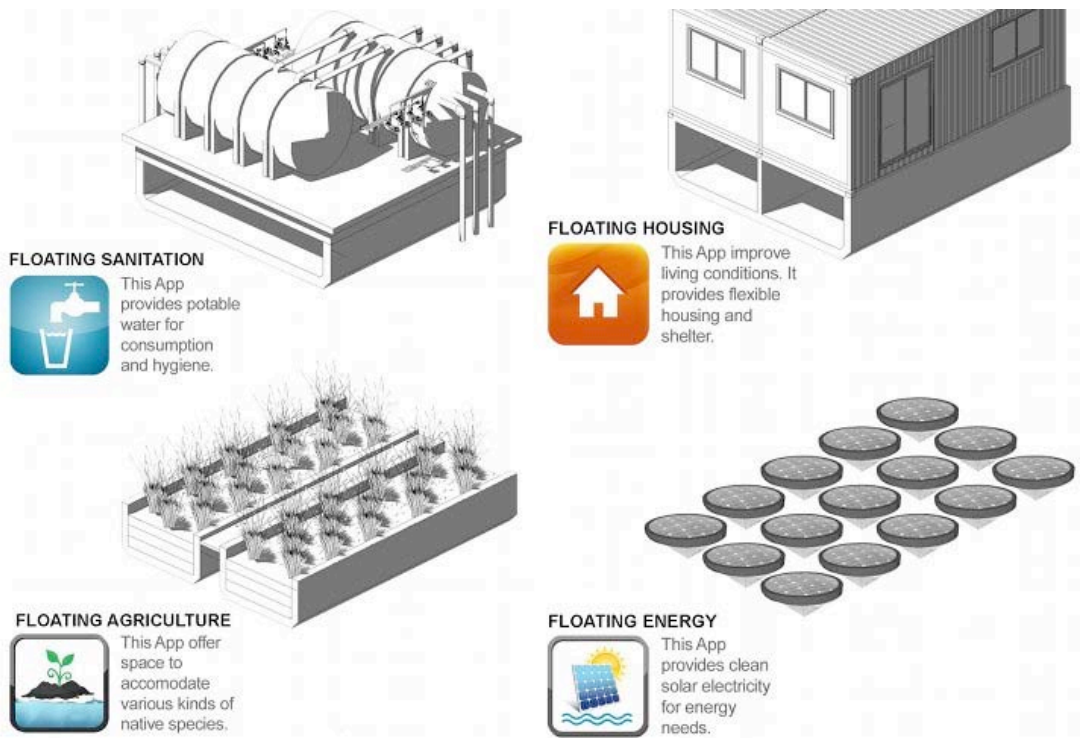
This project by Ken Olthuis and Waterstudio expresses key concepts that this thesis explores. Waterstudio is most known for floating houses that mainly appeal to the wealthy. However, the project / product App-grading Wet Slums is quite the opposite. This idea works to help and improve people that need it most. It implements architectural solutions to the issues that affect the lowest levels of poverty. The objects created float on water adjacent to these wet slums and provide food, sanitation, shelter and energy. They are easily moved elsewhere when there is less need. The idea is interesting but the way that the structure meets the water is problematic. A floating, buoyant concrete pontoon foundation may not be the best solution.



[Figure 42] App-Grading Wet Slums<sup>71</sup>

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<sup>71</sup> David Keuning and Koen Olthuis. *FLOAT!: Building on Water to Combat Urban Congestion and Climate Change*. Amsterdam: Frame Publishers, 2010.



[Figure 43] App-Grading Wet Slums<sup>72</sup>

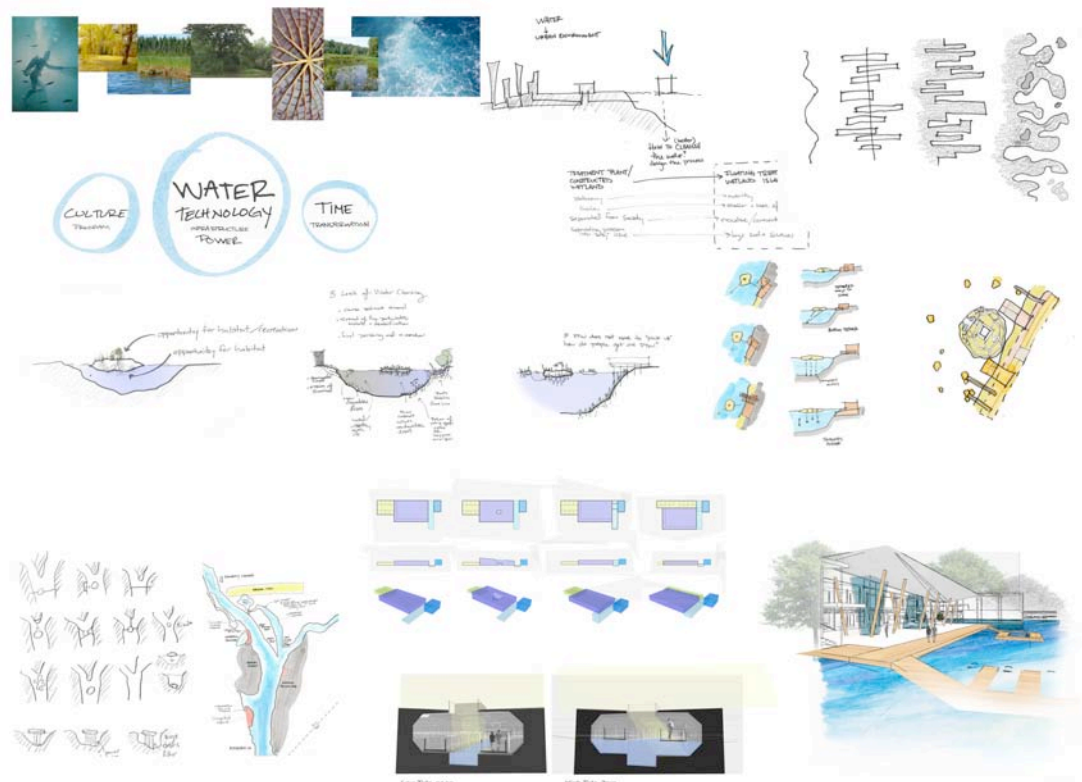
<sup>72</sup> Ibid.



## Chapter 5: Architectural Response

### Potomac Sanctuary Park

The architectural response was presented at the final thesis review on December 17<sup>th</sup>, 2013. The first image depicts process work shown.



[Figure 44] Process Work<sup>73</sup>

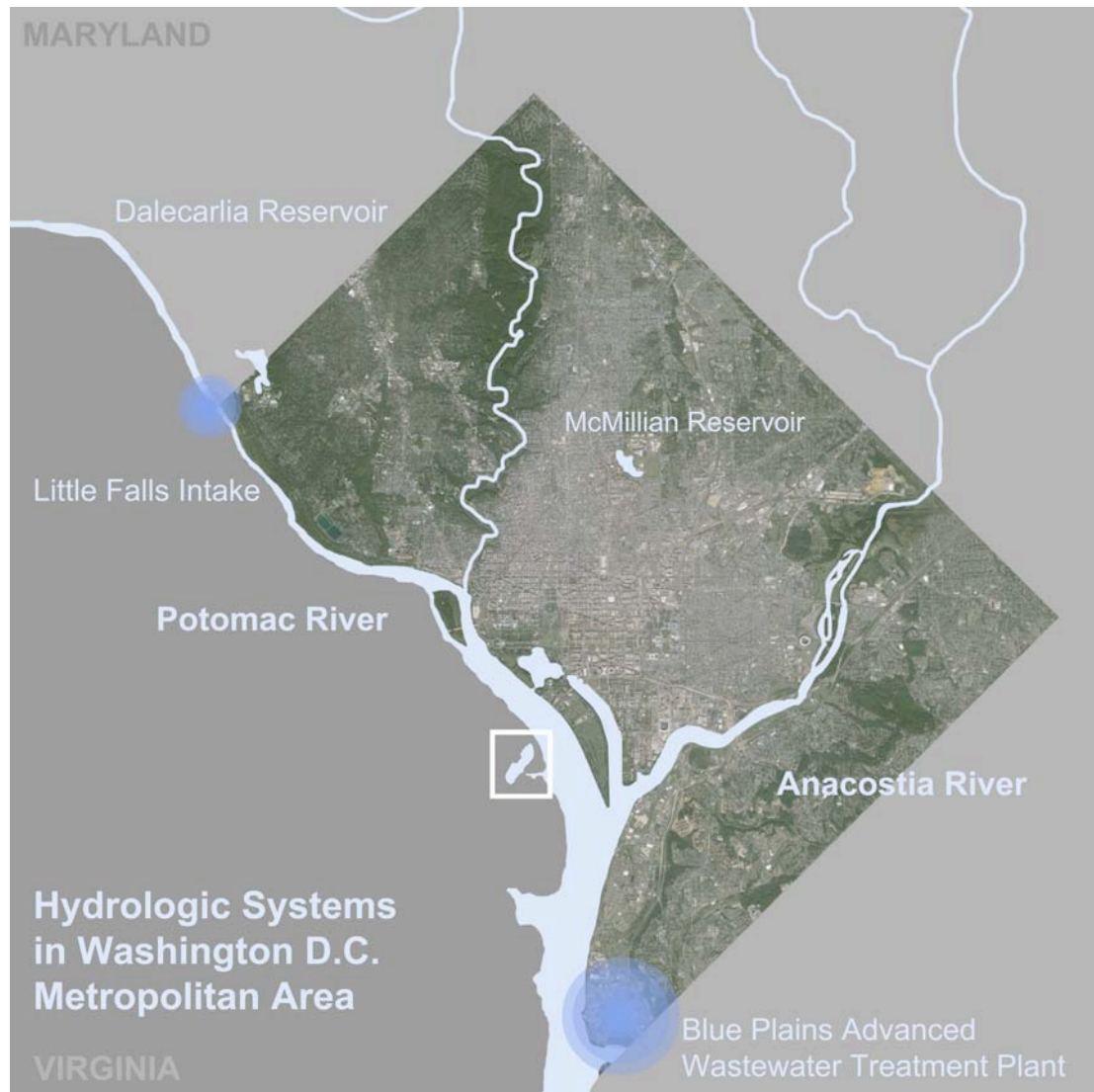
The examination of the site at various scales illustrates the immense nature of the project site.



[Figure 45] Title Image<sup>74</sup>

<sup>73</sup> Images by author

The hydraulic cycle moves water all over the world. The polluted water also moves all over the world. When a cleansing system is put in place, the effects are also felt all over the world. The image above shows where the Potomac River begins and traces it all the way to the Atlantic Ocean. The project is identified in yellow. The next image looks at the movements of water around Washington D.C.



[Figure 46] Hydrologic Systems in Washington D.C. Metropolitan Area<sup>75</sup>

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<sup>74</sup> Image by author

<sup>75</sup> Image by author

This figure ground shows the relationship between the Potomac Sanctuary Park and the Potomac River. The national mall is also shown in close proximity.



[Figure 47] Potomac River Depth<sup>76</sup>

The site plan below showing the Potomac Sanctuary Park illustrates the system of floating treatment wetlands that dot the lake's surface. The different strategies, seen in figure 48, will be present throughout the site. Visitors can experience these

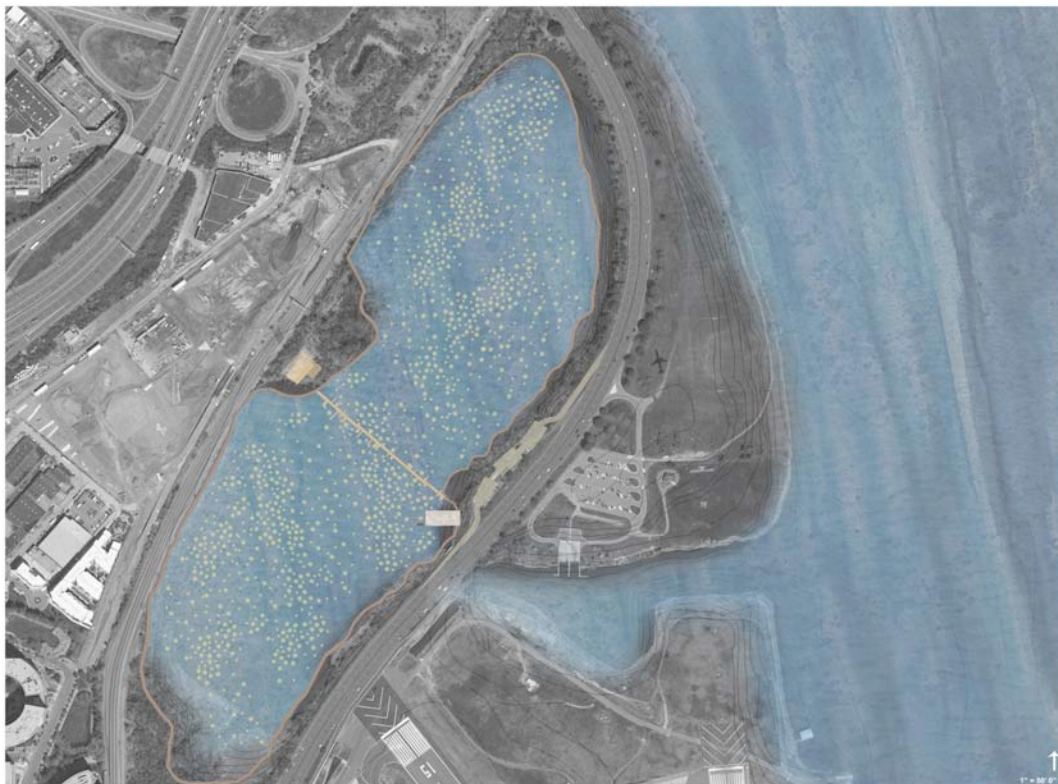
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<sup>76</sup> Image by author




























strategies on the elevated wooden pathway that rings the lake. This pathway can also be used for exercise and recreation.

A floating bridge transects the lake to allow visitors to feel the movement of the water and to provide a different experience of moving through the floating wetlands. The bridge connects the main structure to a secondary boathouse structure on the west side of the lake. Designing the boathouse fell outside the scope of this thesis. It is envisioned to be an outdoor structure that houses kayaks and other man-powered water vessels for use on the site. The vessels can be rented allowing visitors to further immerse themselves in the labyrinth of floating wetlands and also to generate revenue for research.



[Figure 48] Potomac Sanctuary Park Site Plan<sup>77</sup>

## Strategies

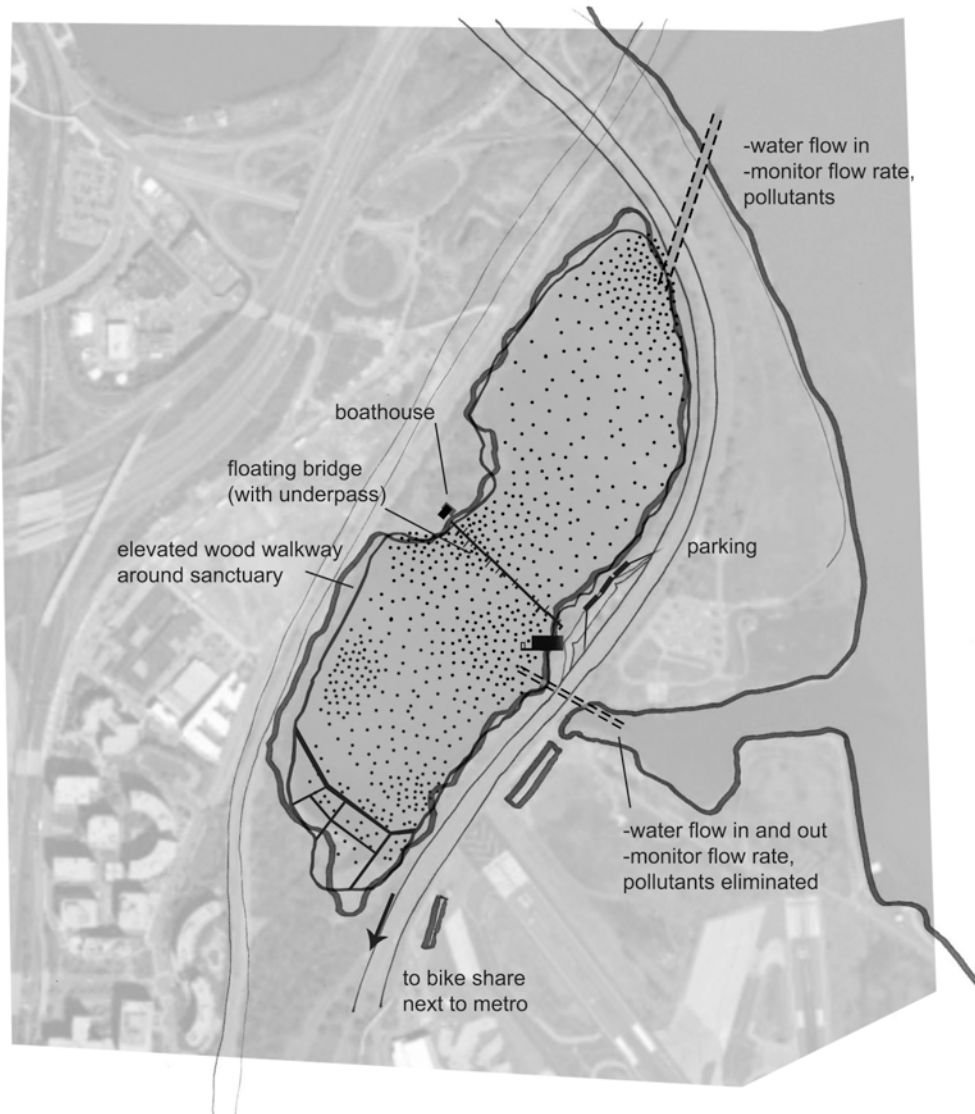
key	cleanse	slow reabsorption	habitat restoration	food	recreation	energy production
						
Goal	What is it	What does it do	Material/how	Where		
cleanse	FTW	removes excess nutrients (nitrates, nitrogen, phosphorous, ammonia)	Floating Treatment Wetland (FTW) through transpiration	floating on water mostly on pond and some in river		
cleanse	Constructed Wetland	removes excess nutrients / prevents shoreline erosion / habitat	Water-tolerant vegetation / filtration materials in soil	shoreline		
cleanse	Absorbent W	attracts oil/toxic chemicals in water, hydrophobic	super absorbent polymer made from used carpet fiber	disconnected pool to test		
cleanse / slow reabsorption	Green Roof	absorb rainwater (prevent runoff) / insulate building	drought resistant vegetation / filtration materials	roof of private		
cleanse / reuse	Blue Roof	collect rainwater, cleanse and store for use in building	collect with folded plate concrete roof, cleanse with vegetation	roof of public		
cleanse / slow reabsorption	Pervious Paving	allows service and personal vehicle passage	structural tiles allow rainwater to enter ground	anywhere parking / driving is needed		
cleanse / slow reabsorption	Smart Streets	cleanses polluted road runoff and helps with flooding	planted with cleansing and water tolerant vegetation	borders all impervious paving		
cleanse / slow reabsorption	Rain Garden	directs water on a site to a cleansing bed	water tolerant / low maintenance vegetation	landscape element to accompany structures		
habitat restoration / cleanse / food	Oysters	naturally filters water / provide food	provide nursery with stakes and netting	near banks		
habitat restoration / recreation / food	Indigenous fish species	restores ecosystem / provides fishing recreation / provide food	bring in healthy adults to breed and monitor	calm ponds for breeding and young		
habitat restoration	Bay Grass	stabilizes shoreline, provides food / habitat for wildlife	bring in young plants and control population	pond / river bed		
recreation	Kayak / rowboat / paddleboat rental / dock	provides connection with water / exploration	buoyant, non-slip wood	adjacent to main structure		
cleanse / recreation	Pool in Pond	cleanse water with filtering walls / connect to water	various filtration materials to naturally strain out impurities	in water near building		
possible energy production	Biofilm	produces energy	Extracellular polymeric substance	on roots in FTW		
possible energy production	Algae fuel	produces energy	Algae	sun and still water		

[Figure 49] Strategies<sup>78</sup>

<sup>77</sup> Image by author



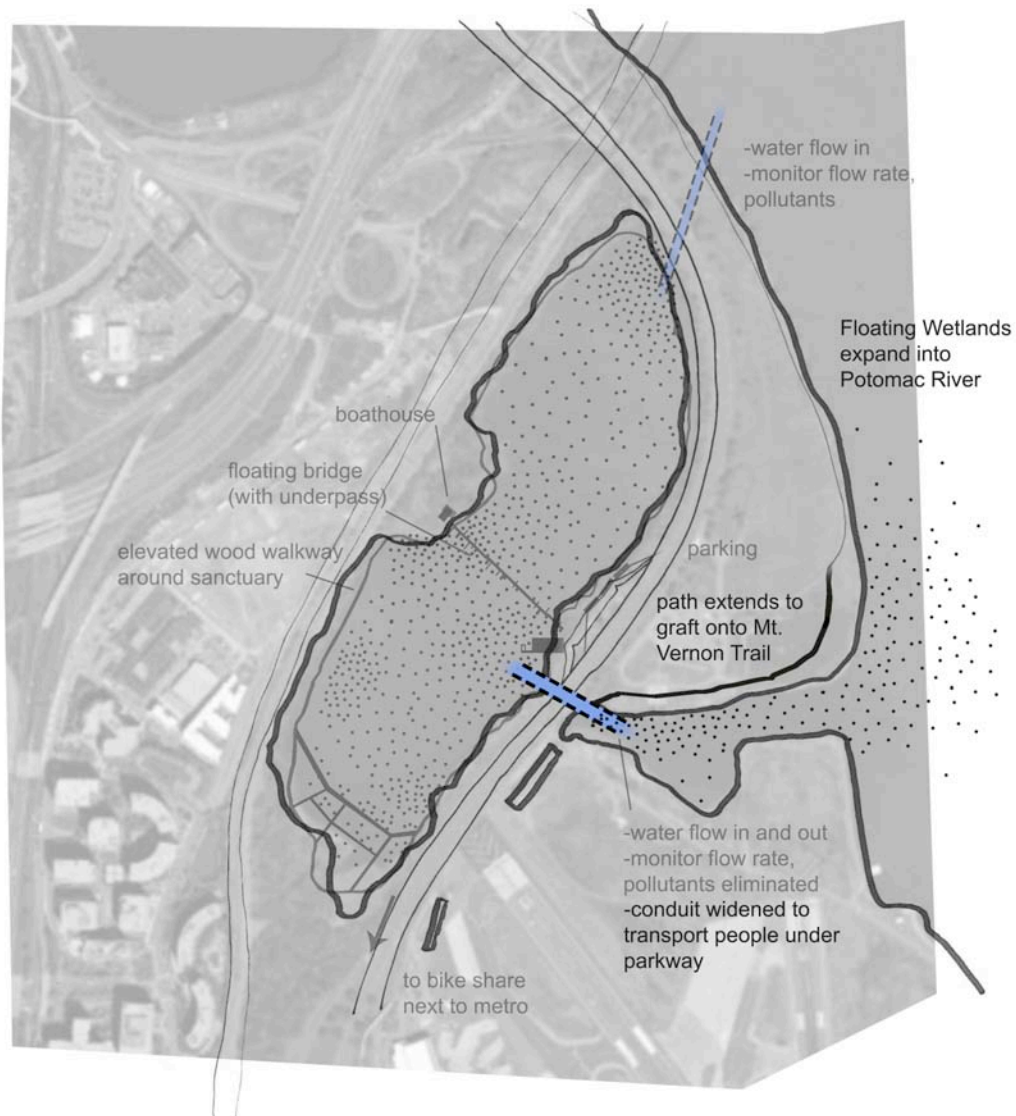
The list of strategies is not exhaustive, but a starting point. This project acts as a catalyst for cleansing efforts. Future development was considered in diagrammatic form.



[Figure 50] Diagram of Site – Phase 1<sup>79</sup>

<sup>78</sup> Image by author

<sup>79</sup> Image by author



[Figure 51] Diagram of Site – Phase 2<sup>80</sup>

After the first phase of the project is complete and successful, the floating wetlands can extend in to the Potomac and increase the cleansing efforts. The conduit that transports was between the lake and the Potomac directly to the south of the building will transform into a walkway below the parkway to allow people to cross the parkway. This will allow a connection between Gravelly Point Park and the Potomac

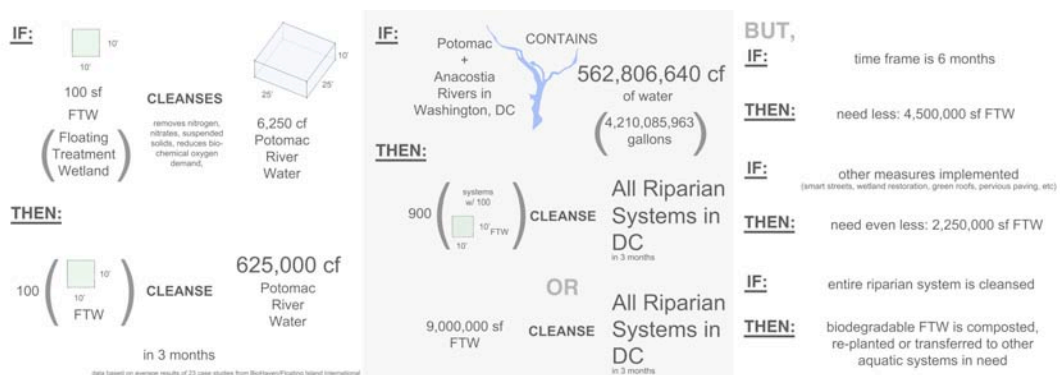
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<sup>80</sup> Image by author

Sanctuary Park. It also allows the path around the lake to be connected to the Mt. Vernon Trail.

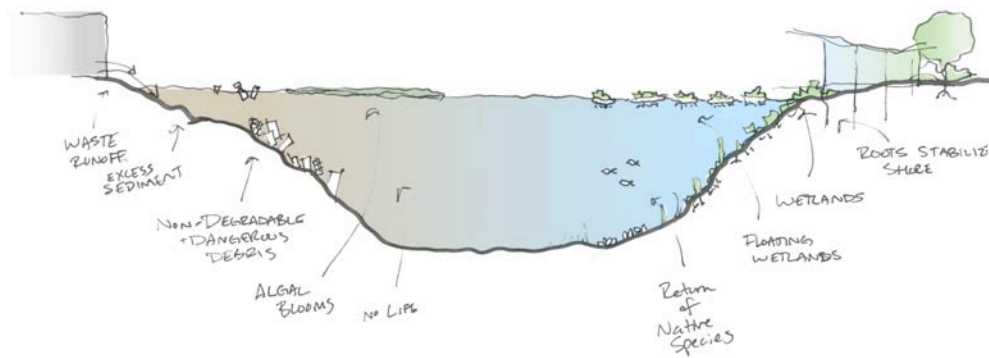
### Research and Education Center

The myriad cleansing components uncovered in this research only scratch the surface of possible ways we can naturally cleanse our waterways. Architecture can create a space to bring all of these elements together to enrich the conversation. The structure will work at different scales educate the community about what they can do at a personal level and also work on large scale urban proposals. The images below illustrate the large-scale thinking and transformative processes being worked on at the site.



[Figure 52] Implications of Cleansing System<sup>81</sup>

<sup>81</sup> Image and calculations by author based on case studies



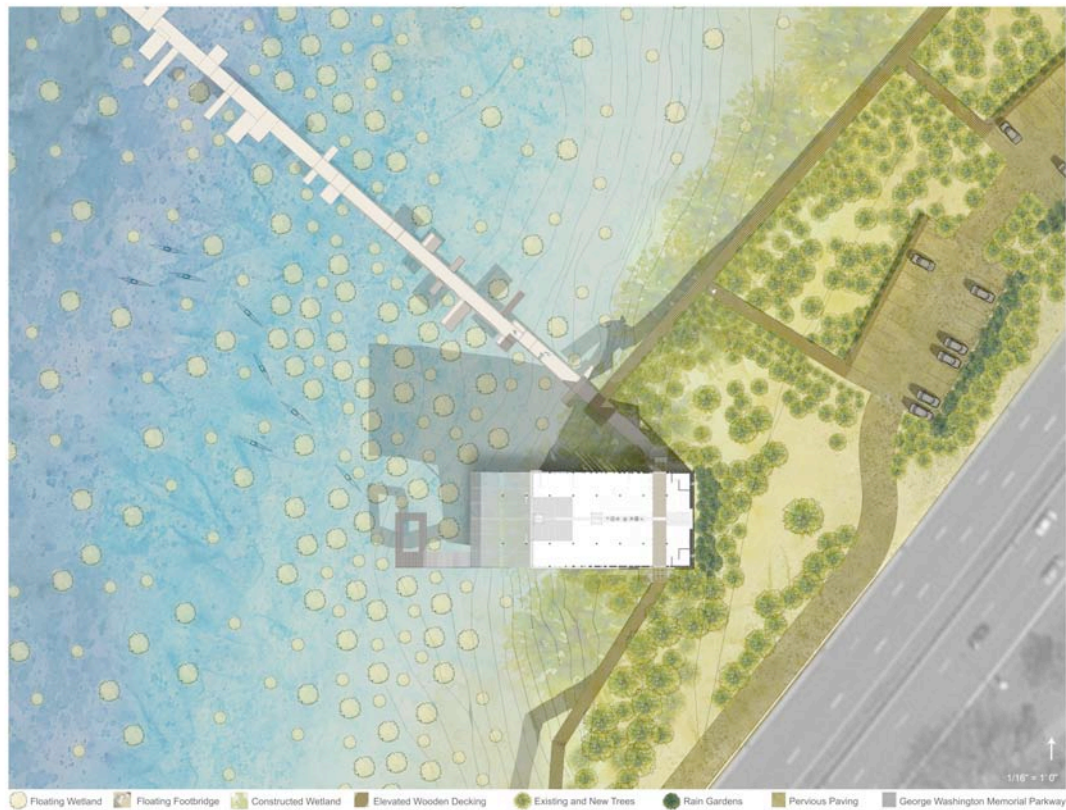
[Figure 53] Transformative Processes<sup>82</sup>

The site can be accessed by car or by bike. The Crystal City metro stop is the closest to the site. With the addition of a bike share to the metro, visitors could access the site without their cars. For those who do drive, they access the parking lot from the George Washington Memorial Parkway and are directed onto a parking surface with pervious paving. The visitors are then drawn through the trees and towards the water. The existing and new trees provides a visual and acoustic separation between the site and the parkway. The elevated wooden walkway provides views of the entire lake, the constructed wetlands and the structure. The visitor can choose to walk right and walk around the lake, walk left and cross the floating bridge, or walk left and enter

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<sup>82</sup> Image by author

the building.



[Figure 54] Potomac Sanctuary Park Research and Education Center Site Plan<sup>83</sup>

The pathway moves through the building in an interior/exterior space so that the building can be experienced in some sense even when it is closed. The pathway can also be used at any time.

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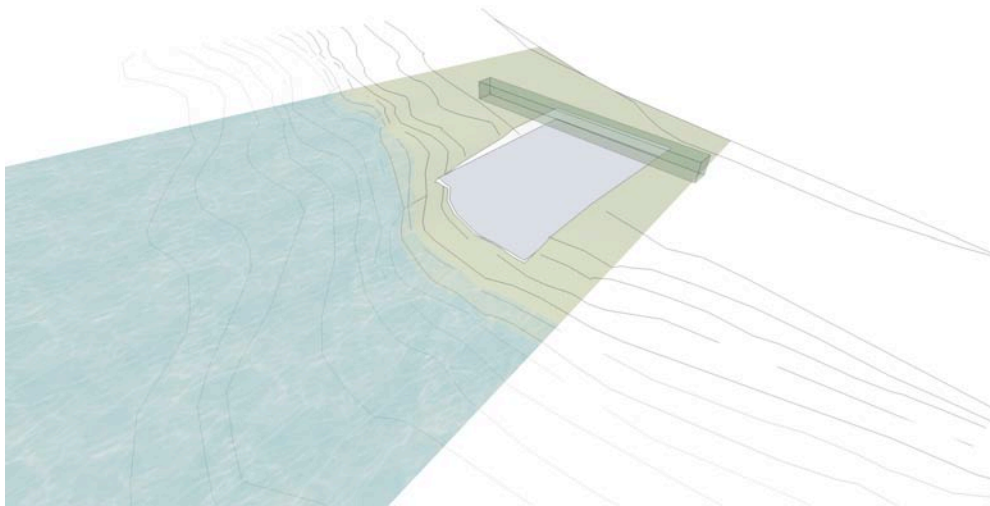
<sup>83</sup> Image by author





[Figure 55] Approaching the South Entrance<sup>84</sup>

The building's main objectives are to take the visitor from the secondary axis parallel to the lake [Figure 56] and orient them towards the water, on the main axis perpendicular to the lake [Figure 57].

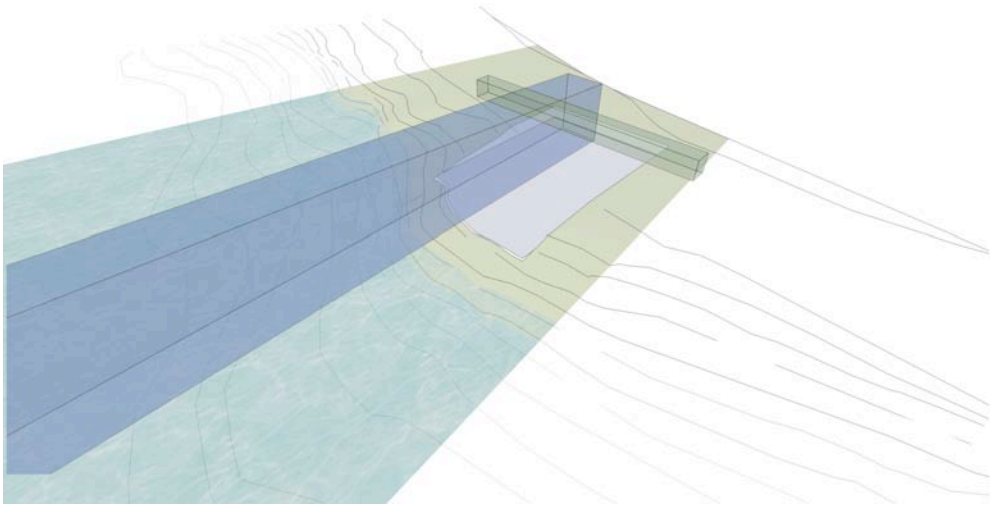


[Figure 56] Diagram of Secondary Axis<sup>85</sup>

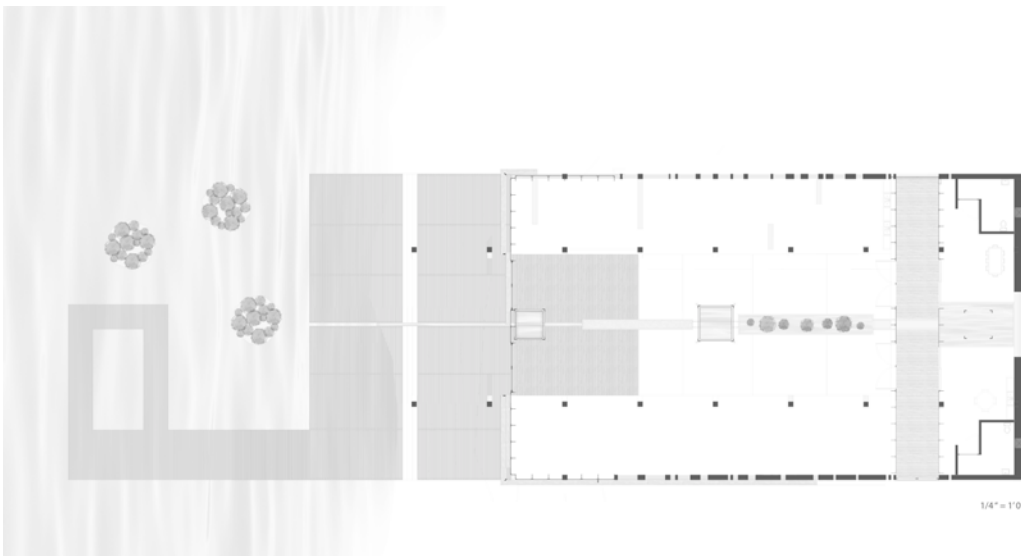
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<sup>84</sup> Image by author

<sup>85</sup> Image by author



[Figure 57] Diagram of Primary Axis<sup>86</sup>

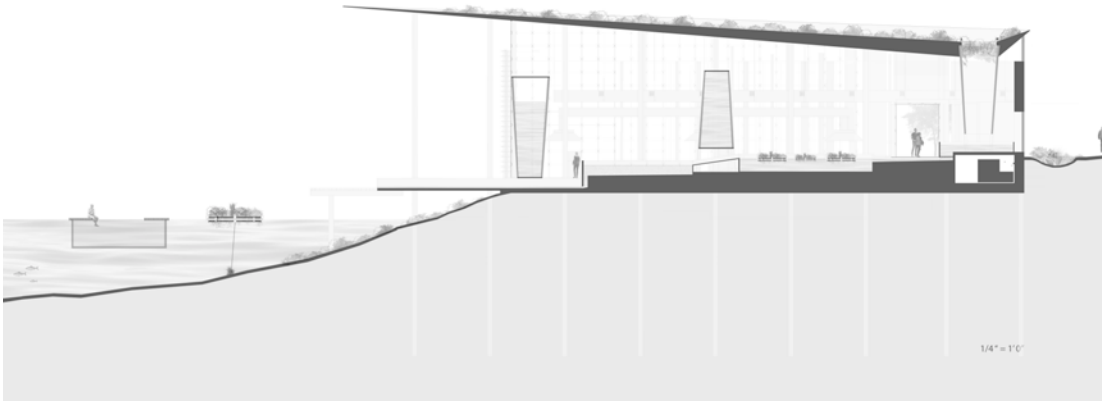


[Figure 58] Plan<sup>87</sup>

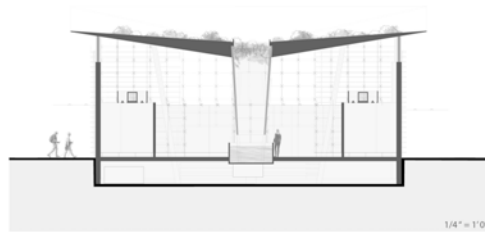
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<sup>86</sup> Image by author

<sup>87</sup> Image by author



[Figure 59] Longitudinal Section<sup>88</sup>



[Figure 60] Transverse Section<sup>89</sup>

The cleansing properties of the site are showcased in the building to illustrate the reason for being of the project and to allow visitors to follow the journey of water from the sky through cleansing and back to the water system. The central space is stepped to allow visitors to cascade down with the water to reach the outdoor space.

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<sup>88</sup> Image by author

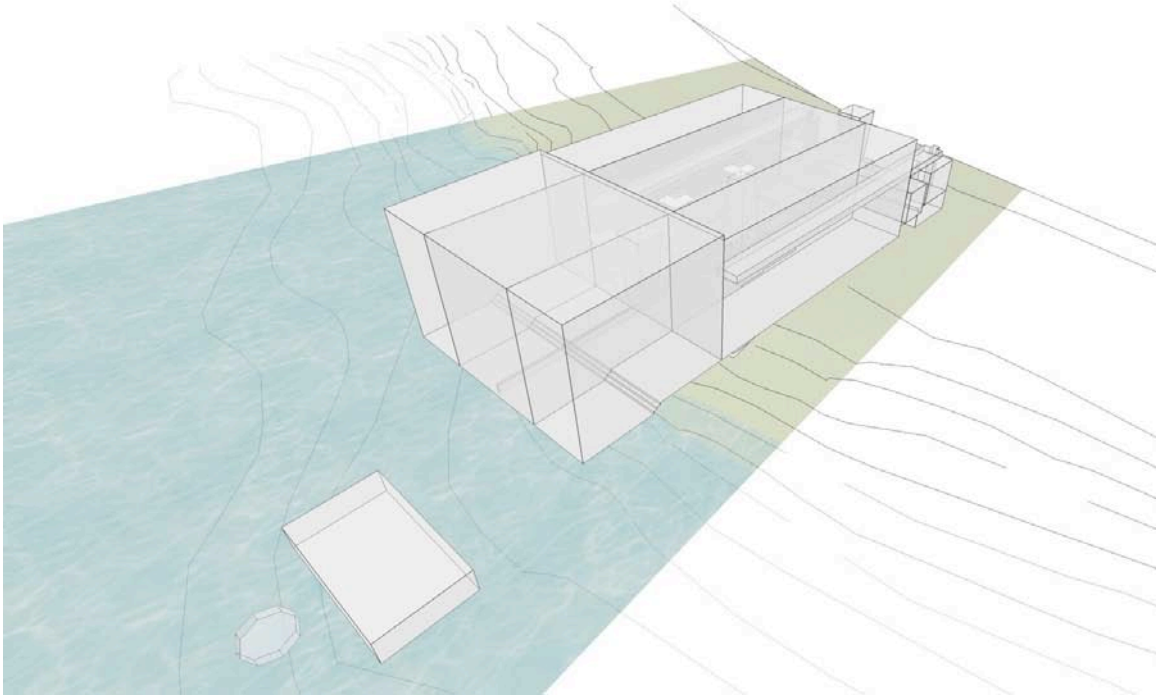
<sup>89</sup> Image by author



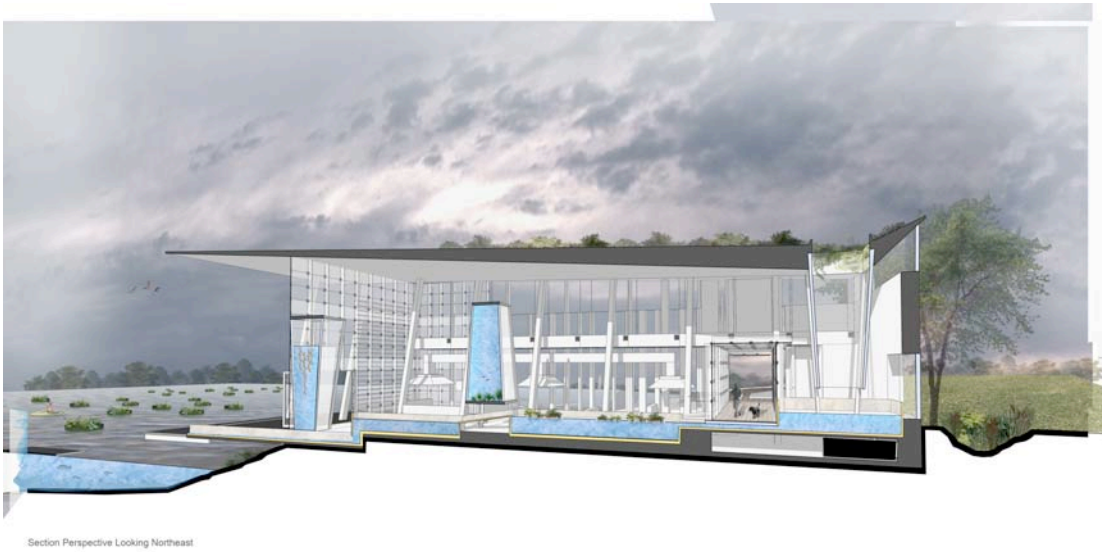
The deck is porous to allow light and views to filter down to the porous edge. On the end of the deck, a hinge connects the floating pool in the lake to the building. The floating deck allows the visitors to directly experience the movement of the water and accommodates the average three foot tidal change. The section of the pool is a filtration wall, acting alike a strainer in the lake and pointing to a time in the future when it is again safe to swim in the Potomac River.

The spaces of the building are illustrated in the image below. The mechanical space is nestled below grade in the east end of the building. The restrooms are above this space. The east end is the most appropriate for these program elements to shoulder up to the highway and provide a separation of the building experience from the parkway. The roof has a puncture on the east end, allowing rainwater to come into the building through the first of three cleansing columns. This brings water into one of three basins to cleanse water. The second basin contains floating treatment wetlands so people can interact with the structures on a more personal level. The third basin contains sand to cleanse the water. The water is then directed into a narrow path that allows the cleansed water to reenter the lake.

This system is main object in the building and reinforces the primary axis to the water. The middle cleansing column on this axis contains indigenous fish species that are being raised on the site. The cleansing column in the west end of the building houses oysters that are being rehabilitated on site. The secondary spaces on either side of the main axis house the research, education and office spaces of the building. The HVAC and lighting system are suspended over these spaces.



[Figure 61] Spatial Diagram<sup>90</sup>

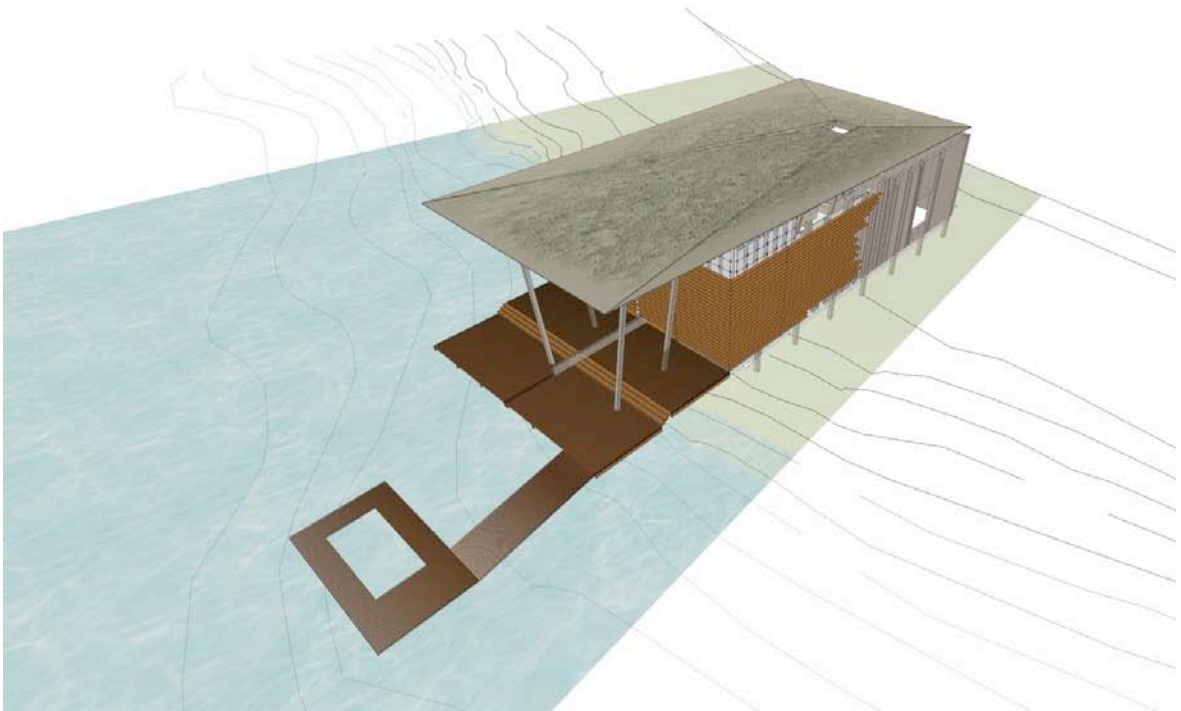


[Figure 62] Section Perspective Highlighting Cleansing Columns<sup>91</sup>

<sup>90</sup> Image by author

<sup>91</sup> Image by author

The materials of the building are illustrated in figure 62. The building is supported by 1' x 1' concrete columns on the exterior. Lateral forces are accounted for in the shear wall structural properties of the concrete walls. The folded plate concrete roof is supported by canted concrete columns that run down the central space of the building. The floor is poured concrete on land and wooden decking as the structure walks out over the water. The façade is one foot thick precast concrete panel on the east side of the building. The concrete façade begins to break up towards the west. The glass between the concrete and that dominates the west façade is a curtain wall connected with spider clips. To account for the powerful sun, a wooden louver system wraps the southern and western facades. The northern façade has a large glazed area to provide views to the capital and Washington Monument.



[Figure 63] Material Diagram<sup>92</sup>



[Figure 64] Structural Detail<sup>93</sup>

<sup>92</sup> Image by author

<sup>93</sup> Image by author



[Figure 65] Perspective Looking East From the Water<sup>94</sup>

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<sup>94</sup> Image by author



Perspective Overlooking Lake, Sunset

[Figure 66] Perspective Overlooking the Sunset on the Lake<sup>95</sup>

As the sun sets, the glowing tubing on the floating wetlands transforms the cleansing agents into light sculptures that dot the water and activate the space and night. They can be seen from the parkway and approaching airplanes to National Airport. The quietude of the space is contrasted with the powerful natural processes at work on the site and in the building.

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<sup>95</sup> Image by author

### *Closing Thoughts*

In sum, this thesis project aimed to examine the possibilities of natural cleansing systems and to produce an inhabitable space that facilitated these processes. I believe that the depth of the scientific discoveries in this project were successful. I believe that the parti and ideas behind the building were also successful. The final design of the building was the least successful part of this thesis. The material choice and placement of certain elements needed further refining, as was pointed out in the review. The commentary that the presentation was clear and easy to understand was a success of which I was particularly proud. The most satisfying part of this thesis process for me was the integration of strange, artistic ideas about cleansing (glowing cleansing islands) with real science and detail to move fantastical and new ideas into reality. I have struggled in the past with grounding my creative architectural ideas in reality. To do that successfully in this thesis process was extremely rewarding and an appropriate end to my graduate education.



## Bibliography

### Relevant Websites:

NOAA.gov

DCwater.com

Google Earth

USGS.com

Material ConneXion database

### Articles:

American Rivers. "American Rivers Names America's Most Endangered Rivers of 2012." Last modified May 15, 2012. <http://www.americanrivers.org/newsroom/press-releases/american-rivers-names-americas-most-endangered-rivers-of-2012/>.

Ayyub, Bilal M., Haralamb G. Braileanu, and Naeem Qureshi. "Prediction and Impact of Sea Level Rise on Properties and Infrastructure of Washington, DC." *Risk Analysis*, Vol. 32, No. 11, 2012.

Chesapeake Bay Program. "Eastern Oyster," *About the Bay*. Retrieved November 11, 2013. [http://www.chesapeakebay.net/fieldguide/critter/eastern\\_oyster](http://www.chesapeakebay.net/fieldguide/critter/eastern_oyster).

Committee on Environment and Natural Resources. 2010. "Scientific Assessment of Hypoxia in U.S. Coastal Waters." Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health of the Joint Subcommittee on Ocean Science and Technology. Washington, DC.

Family and PlayLab, + *POOL*, *Tile by Tile*, accessed September 6, 2013. <http://www.kickstarter.com/projects/694835844/pool-tile-by-tile>.

Floating Island International, *Case Studies*. Accessed March 12, 2013. <http://www.floatingislandinternational.com/research/case-studies/>

Gerhart, J. M., USGS. "National Water-Quality Assessment—Potomac River Basin." Last modified Monday, August 6<sup>th</sup>, 2012. <http://md.water.usgs.gov/publications/ofr-91-157/ofr-91-157.html>.



Interstate Commission on the Potomac River Basin. *Timeline of the History of Water Quality in the Potomac Basin*. <http://www.potomacriver.org/39-facts-faqs/facts-faqs/96-timeline>.

Maltby, Edward. *Waterlogged Wealth: Why Waste the World's Wet Places*. Arlington, VA: AgriBookstore, 1986.

Muskie, Edmund S., *speech, March 1, 1966*. Muskie Congressional Record. <http://abacus.bates.edu/muskie-archives/ajcr/>

Office of Planning (OP) and the District Department of the Environment (DDOE). "Sustainable DC." The District of Columbia, mayor Vincent C. Gray, 2012.

Parry, Wynne, "How High Will Sea Levels Go by 2100?" [www.livescience.com](http://www.livescience.com) accessed November 13, 2013.

Werner, Jeff, captain. *The Potomac River and the Civil War*. Marina Life Magazine. <http://www.marinalife.com/magazine/194-the-potomac-river-and-the-civil-war>.

World Bank Institute. "Water Policy Reform Program." Accessed November 10, 2013. <http://wbi.worldbank.org/wbi/>

da Vinci, Leonardo. *Water – Nature's Driving Force*. <http://www.theleonardo.org/exhibits/discover/past-exhibit/water/>

#### Books:

Ascher, Kate. *The Works: Anatomy of a City*. New York: Penguin Books, 2007.

Attenborough, D. *The Private Life of Plants: A Natural History of Plant Behavior*. London: BBC Books, 1995.

Benyus, Janine M. *Biomimicry: Innovation Inspired by Nature*. New York: HarperCollins Publishers, Inc., 1997.

Bergdoll, Barry. *Rising Currents: Projects for New York's Waterfront*. New York: MoMA, 2010.

Berkebile, Bob, Laura Lesniewski and Steve McDowell. *Flow: The Making of the Omega Center for Sustainable Living*. Berkeley, CA: Publishers Group West, 2010.

Clay, Grady, Ed. *Water and the Landscape*. New York: McGraw-Hill Book Company, 1979.

DeExupéry, Antoine. *Wind, Sand, and Stars*. New York: Reynal and Hitchcock, 1939.

Dreiseitl, Herbert and Dieter Grau. *Recent Waterscapes: Planning, Building and Designing with Water*. Boston, MA: Birkhäuser, 2001.

Dreiseitl, Herbert, Dieter Grau and Karl H. C. Ludwig. *Waterscapes: Planning, Building and Designing with Water*. Boston, MA: Birkhäuser, 2001.

Ellefson, Connie Lockhart, Thomas L. Stephens, and Doug Welsh, Ph. D. *Xeriscape Gardening*. New York: MacMillan Publishing Company, 1992.

Graphic Image Studio Pty Ltd. *Water Spaces of the World*. Melbourne, Australia: The Images Publishing Group Pty Ltd, 2001.

Hamilton Hayne, Paul. *Poems of Paul Hamilton Hayne*. Chapel Hill, NC: University of North Carolina at Chapel Hill, 1999.

Kato, Akinori and Nobuhiro Suzuki, Eds. *Aquascape: Water in Japanese Landscape Architecture*. Tokyo, Japan: Process Architecture Co. Ltd., 1990.

Keuning, David and Koen Olthuis. *FLOAT!: Building on Water to Combat Urban Congestion and Climate Change*. Amsterdam: Frame Publishers, 2010.

Margolis, Liat and Alexander Robinson. *Living Systems: Innovative materials and Technologies for Landscape Architecture*. Boston, MA: Birkhäuser, 2007.

Metz, Tracy and Maartje van den Heuvel. *Sweet & Salt: Water and the Dutch*. Rotterdam: NAI Publishers, 2012.

Nordenson, Guy, Catherine Seavitt and Adam Yarinsky. *On the Water: Palisade Bay*. New York: MoMA, 2010.

Process Architecture and Sasaki Creative Office, Eds. *Aquascapes II*. Tokyo, Japan: Process Architecture Co. Ltd., 1994.

Ryan, Zoë. *Building with Water*. Basel, Switzerland: Birkhäuser, 2010.

Sanderson, Eric W. *Mannahatta: A Natural History of New York City*. New York: Abrams, 2009.

Wylson, Anthony. *Aquatecture: Architecture and Water*. London: Architectural Press Ltd., 1986.

#### David Rumsey Map Collections

Buchon, J.A.C.; Carey, H.C.; Lea, I.  
District de Colombie

Paris: J. Carez, 1825

Colton, G.W.  
Georgetown and the City of Washington  
New York: G.W. & C.B. Colton & Co.

Jones, T.W.; Moore, S.S.  
Road from Philadelphia to Washington  
Philadelphia: Mathew Carey, 1802

Mitchell, Samuel Augustus  
Washington  
Philadelphia: S.A. Mitchell, 1880

Peripheral Inspiration:

Cousteau, Jacques-Yves with Frédéric Dumas and James Dugan. *The Silent World*.  
New York: Ballantine Books, 1953.